General Reference: 1.1 Basic Fire Alarm Systems

Types of fire alarm Systems

1. Local systems don't communicate: the purpose evac
2. Auxiliary systems connect to street boxes
3. Remote station installation not UL most common sys
4. Proprietary station under 1 ownership (ie colleges)
5. Central station requires UL install, UL monitoring
6. Central station requires certificate / placard
7. Runner service required for Central & Proprietary

Types & spacing of initiating devices

8. Heat det have listed spacing determined by UL
9. Smoke det do not have listed spacing, 30' permitted
10. Pull stations mount 3.5'-4.5' to actuator
11. Pull stations located within 5' of exit doorway
12. Max travel distance to nearest pull 200'
13. Waterflow max retard 90 sec must be wired to FACP
14. Systems with waterflow or auto det require 1 pull
15. Supervisory air pressure actuation +/- 10 psi
16. Control valve actuation with 2 turns of handwheel

Types & spacing of notification appliances

17. Horns sound at 15db above ambient, 5db above max
18. Horns sound at 120db max
19. Mount horns 90" AFF min to top of device
20. Strobe flash rate 1 flash/sec min, 2 flash/sec max
21. Mount strobes so entire lens is 80" up to 96" AFF
22. Combination devices, mount to strobe requirements
23. Private mode notification small group to verify signal
24. Public mode notification for all occupants

Power & Electrical Requirements

25. Require 2 reliable power supplies (primary/standby)
26. Overcurrent protection not to exceed 20 amps
27. Auto transfer to standby must occur within 10 sec
28. When primary power fails, no signals shall be lost
29. Commercial system standby 24 hours / 5 minutes
30. Voice Evac standby 24 hours / 15 min at max load
31. Household standby 24 hrs / 4 min
32. All installation conductors shall be supervised
33. Trouble signal shall be indicated in 200 seconds

Control function requirements

34. Types of signals, alarm, supervisory, trouble
35. Indication times, alarm 10, sup 90, tbl 200 sec

General Reference: 1.2 NFPA Standards
Related References: None

Application of the codes to fire alarm systems

1. NFPA 70, NEC specifies wiring requirements
2. NFPA 72 specifies how to install fire alarm equip
3. NFPA 101 specifies which occupancy require system
4. NFPA 13 Standard for sprinkler systems
5. NFPA 90A HVAC Units (smoke duct detectors)
6. NFPA 170 Fire alarm symbols
7. NFPA 601 Security in fire loss prevention (Guards)

Common NFPA standard terminology

8. Should = a code recommendation
9. Always follow code recommendations
10. Shall = a code requirement
11. Authority Having Jurisdiction = AHJ
12. AHJ = inspector, fire marshal, insurance rep, owner
13. * = explanatory information in Annex A
14. [ ] = information from other codes
15. • = deleted information from the previous edition
16. | Vertical line in left margin = changed information

Concepts of approved, listed and role of UL

17. Approved = acceptable to the AHJ
18. AHJ approves procedures and methods
19. Listed = equip/svcs evaluated and published in a list
20. Labeled = listed equip with an attached label
21. Compatibility listed applies to 2 wire smoke det
22. Compatibility listed applies to addressable devices
23. UL = Underwriter's Laboratories
24. UL tests equip & services to a certain standard
25. UL lists tested equipment in a publication
26. FM Global also tests equip & services to standard
27. All fire alarm equipment must be listed for use

Selection of the correct NFPA standard

28. NFPA Standards are designed to work together
29. When = NFPA 101 bldg occupancy FA requirements
30. How = NFPA 72 fire alarm equip installation code
31. Wiring = NFPA 70 National Electrical Code
32. HVAC = NFPA 90A which units require detectors
33. Guard tour = NFPA 601
34. Sprinkler installation = NFPA 13
35. 1st identify occupancy and FA requirements (101)
36. 2nd identify equip install requirements (72)
37. 3rd identify wiring requirements (70)

General Reference: 1.3 Basic Wiring

Related References:	Basic Electricity	pg 6
	Installation Practices	pg 9
	Electrical Installation	pg 19
	Fire Alarm System Wiring	pg 50

Wiring requirements for fire alarm systems

1. NFPLFA = Non Power Limited Fire Alarm (120 V)
2. NFPLFA requires insulation rated at 600 V
3. PLFA = Power Limited Fire Alarm (12 or 24 V)
4. PLFA requires insulation rated at 300 V
5. Min wire gauge for PLFA = 18 AWG single conductor or 26 AWG for multiconductor
6. Min wire gauge for NPLFA = 18 AWG
7. Types of cable General purpose (GP), Riser, Plenum
8. Plenum=least toxic, Riser=middle, GP=most toxic
9. See cable substitution charts in Chuck Notes
10. Class 1 remote control = 600v max, current unlimited
11. Class 1 power limited = 30v max, power 1000va max
12. Class 2 circuit = 30v, 100va or 150v, .5va
13. Class 3 circuit = 150v, 100va

Requirements for protection of wiring

14. Exposed wiring shall be protected within 7' AFF
15. Fire alarm circuits / junctions shall be clearly marked
16. Overcurrent protection 18 AWG = 7 A, 16 AWG = 10A, 14 AWG = 15 A, 12 AWG = 20 A
17. Wiring shall be attached to permanent bldg structure
18. Fire barrier penetrations shall be sealed
19. Access above ceiling tiles shall not be obstructed
20. Wiring cannot be strapped to someone else's conduit

Outlet / junction box fill requirements

21. See Chuck Notes, Brown Book, or Ugly's

Conduit fill requirements for conductors of 1 size

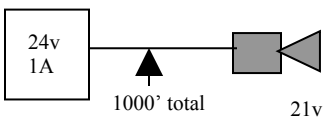
22. See Chuck Notes, or Ugly's

Calculate proper wire size

23. See Chuck Notes
24. Sample problem:

What is the proper wire size for this circuit?
16 AWG
14 AWG
12 AWG
10 AWG

Answer = c. 12 AWG



Solve using these steps
24v – 21v = 3v
3v = max voltage drop on wire
Look at chart for correct AWG

General Reference: 1.4 Devices and Components

Operation & use of manual fire alarm boxes

1. Pull station mounting = 3.5' – 4.5' to the actuator
2. Locate pull stations within 5' of exit doorways
3. Pull stations shall be unobstructed
4. Pull stations shall be located so that max travel distance to the nearest device doesn't exceed 200'
5. Group openings over 40' require pull on each side
6. Coded pull stations shall produce 3 repititions
7. FA systems with waterflow or smokes need 1 pull
8. Pull stations required at each exit on each floor
9. Combination pull station/guard station is permitted

Operation & use of automatic detectors

10. Spot type heat detectors are located in one spot
11. Line type heat detectors used in cable trays
12. Fixed temp actuate when temp threshold is reached
13. Rate of rise actuate with temp increase of 10º/minute
14. Reduce spacing for ceilings over 10' high (see Chuck Notes or NTC Brown Book)
15. Smoke detector spacing permitted to be 30' for ceilings up to 28' high
16. Ionization uses radiation chamber to detect smoke
17. Photoelectric detector use principle of light scattering
18. Photobeam detector use principle of light obscuration
19. All detectors shall be at least 4" away from corners
20. Wall mounted detectors shall be within 12" of ceiling
21. For spacing requirements see Brown Book

Operation & use of audible/visible appliances

22. Notification nameplates shall include electrical req
23. Nameplates shall have audible/visible performance
24. Appliances in special environments shall be listed
25. Protective guards shall be listed for use with device
26. Ambient sound level more than 105db require strobe
27. Sleeping area min sound level is 15db above ambient
28. Visible appliances shall be clear or nominal white
29. Maximum candela rating is 1000cd
30. Visible appliances in corridors 15' from end and max spacing is 100' between devices
31. More than 2 strobes in any field of view shall be synched

Operation & use of other system components

32. Other system components shall be listed for use

General Reference: 1.5 Periodic Tests

Related References: Acceptance Testing pg 25
Fire Alarm System Maintenance pg 49

Periodic equipment testing procedures

1. Notify all signal receiving stations at start of testing
2. Notify bldg occupants at start of testing
3. Service tech shall be qualified (NICET State, Factory)
4. Bldg owner responsible for testing & inspections
5. Notify bldg owner of defects if not fixed in 24 hrs
6. At conclusion of testing all shall be notified

Periodic circuit testing procedures

7. Prior to connecting devices check wiring for opens, shorts, ground faults and resistance
8. Record all circuit testing information
9. Test for ground fault by grounding any conductor

Frequency of tests

10. Testing frequency shall comply w/ NFPA 72 Chap 10
11. See Chuck Notes testing frequency table
12. See Brown Book for testing frequency table
13. Smoke det sensitivity shall be tested within 1 year
14. Smoke det sensitivity shall be tested alternate years
15. If smoke det remains within listed sensitivity after 2nd test, then sensitivity tests can be extended to 5 years
16. Smoke det sensitivity shall be tested using calibrated test method, manufacturers device, listed control, other method approved by the AHJ
17. Smoke det which fail shall be cleaned or replaced

Testing methods

18. Smoke detectors shall be functionally tested by introducing smoke into the chamber
19. Waterflows shall be tested by actual flowing of water
20. Discharge testing of suppression system shall not be required
21. Acceptance testing shall be done for all new systems
22. Reacceptance testing is required when system components are added or deleted, modifications to system components or wiring, changes to software
23. All components known to be affected shall be tested
24. 10% of initiating devices not affected shall be tested
25. A revised record of completion shall be prepared
26. Changes to control equipment require a 10% functional test of the system
27. If a monitored control performs weekly automatic testing, manual tests can be extended to annual

General Reference: 1.6 Basic Electricity

Related References:	Installation Practices	pg 9
	Electrical Installation	pg 19
	Fire Alarm System Wiring	pg 50

Characteristics of DC circuits

1. Ohm's Law E = I x R, Power Law P = E x I
2. E = Voltage = pressure which moves current in circuit
3. I = Current = amount of electrons flowing in circuit
4. R = Resistance = opposition to current flow
5. P = Power = amount of work done expressed in VA

Apply ohm's law

6. Find V where I = 2 and R = 6, V = 2 x 6, V = 12 volts
7. Find I where V = 12 and R = 6, I = 12 ÷ 6 = 2 amps
8. Find R where V = 12 and I = 2, R = 12 ÷ 2 = 6 ohms
9. Find P where V = 12 and I = 2, P = 12 x 2 = 24 VA

Characteristics of series / parallel circuits

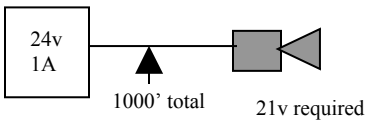
10. Voltage is additive in series circuits
11. Current is constant in series circuits
12. Resistance is additive in series circuits
13. Voltage is constant in parallel circuits
14. Current is additive in parallel circuits
15. Total resistance is less than the value of the smallest resistor in parallel circuits

Voltage drop calculations

16. Using a wire gauge which is too small results in a large voltage drop on the wire
17. Voltage drop can cause devices to malfunction

What is the proper wire size for this circuit?
16 AWG
14 AWG
12 AWG
10 AWG

Answer = c. 12 AWG



Solve using these steps
24v – 21v = 3v
3v = max voltage drop on wire
Look at chart for correct AWG

Use of a Volt/Ohm meter

18. Reading current: Power on, VOM in series w/circuit
19. Reading resistance: Power off, VOM in parallel
20. Reading voltage: Power on, VOM in parallel
21. Make sure the meter is on the correct setting

Characteristics of AC circuits

22. See Ugly's Electrical Reference

General Reference: 1.7 Basic Working Drawings

Related References:	Fire Alarm Symbols	pg 17
	Plans & Specifications	pg 26
	Surveys for Fire Alarm Systems	pg 48

Basic requirements for working drawings

1. Contract drawings show how system is proposed
2. As built drawings show how system actually installed
3. Point to point drawings show terminal connections
4. Riser diagrams show system circuits, typical devices, and conductor counts
5. Owner shall be provided with an owners manual, installation manuals and 3 copies of as builts

Demonstrate good drafting techniques

6. Pencil hardness scale: soft 2, 2.5, 3, 4, 4.5 hard
7. Blue print thin lines are 0.01" thickness
8. Blue print medium lines are 0.015" thickness
9. Blue print thick lines are 0.020" thickness
10. Border lines are thick and identify the border of print
11. Object lines are thick and identify an object on print
12. Dimension lines are thin and detail measurement
13. Hidden lines are medium thickness and dotted

Standard practices for simple layouts

14. Fire alarm submittal documents should include specifications, contract drawings, point to point and riser diagram, equip data sheets, volt drop & batt calc
15. Indicate conductor counts on diagrams
16. Include wire size and lengths on drawings
17. Show location of fire alarm control, power boosters and annunciators
18. Diagrams should be CAD

Determine quantity of fire alarm devices

19. Smoke detectors permitted to be spaced at 30 feet
20. Heat detectors spacing based on listed spacing
21. 1 smoke detector covers 30' x 30' room = 900 sq feet
22. Reduce spacing for irregular ceilings
23. Photobeam detectors typically spaced at 60'
24. Smoke detector required at control for protection
25. At least 1 notification appliance required per floor
26. Check with NFPA 101 or bldg code for design req

Prepare a job materials list

27. Include quantity of devices and actual part numbers
28. Include actual costs of devices
29. Wire lengths plus conduit, boxes and connectors
30. Include any specialty tools required for installation

General Reference: 1.8 Basic Mathematics
Related References: None

Solve simple addition & subtraction problems

1. Use a basic calculator to solve math problems
2. Solve 57 + 22 = 79
3. Solve 15 - 8 = 7
4. Solve 1743 + 8729 = 10,472
5. 0.5 + 0.077 = 0.577
6. 217.33 + 102.76 = 114.57

Solve basic multiplication & division problems

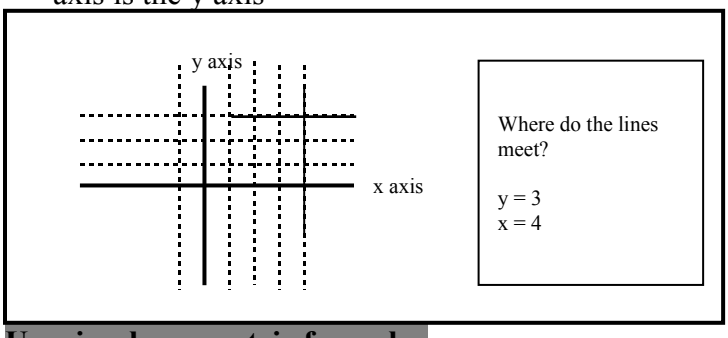
7. Solve 8 x 12 = 96
8. Solve 256 x 17 = 4352
9. Solve 28 ÷ 4 = 7
10. Solve 2397 ÷ 29 = 82.66
11. Solve .23 ÷ .044 = 5.23

Use exponents and round numbers

12. Solve $3^2 = 3 \times 3 = 9$
13. Solve $3^3 = 3 \times 3 \times 3 = 27$
14. Solve $10^4 = 10 \times 10 \times 10 \times 10 = 10,000$
15. Assume application requires 14.36 smoke detectors.
    Round to appropriate number 14.36 = 15
    For fire alarm equip, round to greater quantity
16. Round 25.15478 to the nearest $10^{th} = 25.2$

Calculate percent and use graphs

17. When calculating percent, move decimal point 2 places to the left. 10% = 0.10
18. Solve 10% x 2300 = 0.10 x 2300 = 230
19. Solve 33% of 100 = 0.33 x 100 = 33
20. For graphs horizontal axis is the x axis, vertical axis is the y axis



Use simple geometric formulae

21. Area = length x width
22. Volume = length x width x height

General Reference: 1.9 Installation Practices

Related References:	Basic Wiring	pg 3
	Basic Electricity	pg 6
	Electrical Installation	pg 19
	Wiring	pg 50

Installation methods and proper connections

1. All wiring shall be attached to the building structure
2. Devices shall be supported independent of conductors
3. FA wiring shall be protected within 7' of the floor
4. All installation conductors shall be supervised
5. Devices shall have duplicate terminals
6. Wiring shall be cut at each device, not looped
7. Devices shall be mounted in their proper orientation
8. T tapping is not permitted for conventional or class A

Location of initiating and notification devices

9. Pull station mounting = 3.5' – 4.5' to the actuator
10. Locate pull stations within 5' of exit doorways
11. Pull stations shall be located so that max travel distance to nearest device doesn't exceed 200'
12. Reduce heat det spacing for ceilings over 10' high (see Chuck Notes Chap 5, NTC Brown Book Chap 5)
13. All detectors shall be at least 4" away from corners
14. Wall mounted detectors shall be within 12" of ceiling
15. For spacing requirements see Brown Book Chap 5
16. Sleeping area min sound level is 70db at pillow
17. Visible appliances in corridors 15' from end and max spacing is 100' between devices
18. More than 2 strobes in field of view shall be synched
19. Smoke detectors shall not be in areas where temp is below 32º F, temp is above 100º F, relative humidity exceeds 93%, air velocity exceeds 300'/min

Location of control equipment per NFPA

20. Control equipment shall be operate at 85% of voltage
21. Control equipment shall operate at 110% of voltage
22. Control equip operational temp range is 20º - 120º F
23. Control equip shall operate at 85% humidity
24. Annunciators shall be located for responding persons
25. Control equipment shall be located so as to prevent unauthorized access to equipment

Proper operation of the system

26. All circuits shall test free of grounds
27. Systems shall audibly & visibly display alarm, trouble and supervisory signals
28. Bldgs shall be separately zoned
29. Each floor shall be separately zoned

General Reference: 1.10 Basic Communications
Related References: None

Proper punctuation

1. A period [.] is used at the end of a sentence
2. A question mark [?] is used at the end of a question
3. An exclamation point [!] is used at the end of a sentence to indicate excitement
4. A colon is used to indicate the start of a list
5. A semi colon is used to connect complete sentences which are related
6. There are 10 correct uses for commas

Proper vocabulary

7. The dictionary identifies the origin of words using [ ]
8. Many English words come from greek or latin source
9. Study common prefix and suffix from the dictionary to build your vocabulary
10. Get familiar with commonly misused words.
11. Homonyms, words which sound the same but are spelled differently and have different meanings
    shone / shown, board / bored, pain / pane, allusions / illusions, affect / effect, accept / except

Proper spelling

13. Learn the 10 rules of spelling. Here are 5 rules:

-add a prefix without changing spelling for most words
-add a suffix which starts with a consonant usually does not change the spelling of the word
-suffixes do change the spelling of a word ending in y
-when adding a suffix that begins in a vowel to a word ending in e, drop the final e
-for 1 syllable action words, add a consonant when changing form

14. Get familiar with commonly misspelled words

Proper sentence structure

15. Sentences represent a complete thought
16. Sentences need to be balanced. This means ideas are presented in the same form.
    Incorrect: He liked swimming and to dive.
    Correct: He liked swimming and diving.
    Incorrect: It is both stimulating and makes me tired.
    Correct: It is both stimulating and tiring.
    Incorrect: Joe is a good dad and a fine electrician also.
    Correct: Joe is a good dad and also a fine electrician.

General Reference: 1.11 Basic Metric Conversions
Related References: None

Perform conversions to and from basic metric units

1. Linear measurements
   1 inch = 2.54 centimeters
   12 inches = 1 foot = 3.048 decimeters
   36 inches = 3 feet = .9144 meters
   5280 feet = 1 mile = 1.609 kilometers
2. Square measurements
   1 ft^2 = 144 $inches^2$ = .0929 m^2
   1 yd^2 = 9 ft^2 = .836 m^2
   1 acre = 4840 yd^2 = 43560 ft^2 = 4046.856 m^2
   1 $mile^2$ = 640 acre = 1 section = 2.5899 km^2
3. Cubic measurements
   1 ft^3 = 1728 in^3 = .02831 m^3
   1 yd^3 = 27 ft^3 = .76455 m^3
   1 ft^3 = 7.48 gallons = .02831 m^3
   1 gallon (water) = 8.34 lbs = 231 in^3
   Metric unit of cubic measure is the STERE
   1 yd^3 = .76455 steres
   1 stere = 1.307986 yd^3
4. Liquid capacity
   8 ounces = 1 cup
   16 ounces = 2 cups = 1 pint
   32 ounces = 4 cups = 1 quart
   64 ounces = 8 cups = ½ gallon
   128 ounces = 16 cups = 1 gallons
   1 quart = .9463 liters
   1 liter = 1.0567 quarts
5. Weight measurements
   400 grains = 1 ounce
   1 ounce = 28.3495 grams
   1 pound = .453592 kilograms (kgs)
   1 ton = 2000 pds = 907.1847 kgs = .907 metric tons
6. Temperature conversions
   Fahrenheit to Celsius $C^o = .55(F^o - 32)$
   Celsius to Fahrenheit $F^o = (1.8 \times C^o) + 32$
   0º C = 32º F
   100º C = 212º F
   75º F = 23.65º C
7. Capacity measurements
   1 centiliter = 10 milliliters = .338 fluid ounces
   1 deciliter = 10 centiliters = 3.38 fluid ounces
   1 liter = 10 deciliters = 33.8 fluid ounces
   1 kiloliter = 1000 liters = 264.2 gallons

Special Reference: 1.1 Plans, Specifications and Contracts

Related References:	Basic Working Drawings	pg	7
	Fire Alarm Symbols	pg	17
	Construction Plans	pg	26
	Surveys for Fire Alarm Systems	pg	48

Site plan requirements and specifications

1. Site plans are drawn in PLAN view which is "as looking down from the top"
2. Site plans are drawn to scale with location of utilities
3. Fire alarm contractors use site plans to prepare fire alarm contract drawings which include all fire equip
4. Site plans are prepared by certified land surveyors
5. Site plans include legend, surveyor name, north arrow
6. Specifications part 1 = General Clauses
7. Specifications part 2 = Technical Instructions
8. Specifications part 3 = Acceptance of System
9. Most specifications today are generated using special software specifically designed for the purpose

Contracting relationships in the industry

10. The building owner normally contracts with an architect or engineering firm for plans
11. The owner contracts with a general contractor for construction of the building
12. The general contractor subcontracts various specialty areas like the electrical work
13. Electrical work is covered in division 16 of the contract documents
14. The electrical contractor typically subcontracts the fire alarm system to a fire alarm contractor
15. The architect may contract with an engineering firm for specialty work like electrical systems
16. For Central Station fire alarm systems a special contract arrangement must be established:
    - -The bldg owner may contract with a listed installation company
    - -The bldg owner may contract with a listed monitoring station (central station)

Use plans and specifications for fire alarm systems

17. Site plans are used for fire alarm Take Offs
18. Take Offs measurements used to determine the required number of devices and locations
19. Specifications may require additions to the code

Calculations for fire alarm requirements

20. Based on take offs, determine device requirements
21. Perform battery and voltage drop calculations

Special Reference: 1.3 Basic Physical Science
Related References: None

Terms definitions and concepts from mechanics

1. Mechanics = the study of the interactions of matter and the forces acting on it.
2. Force (*F*) = an agency that changes the momentum of a body or object, expressed as *mass* x *acceleration*.
3. Newton's laws of motion:
   a. A body in motion or will stay as it is unless acted on by an outside force.
   b. The change in momentum of a moving object is in proportion to and in the same direction as the force acting on it.
   c. When one object exerts a force on another, there is an equal and opposite *reaction* force exerted on the first object by the second object.
4. Pressure = a force acting on an area.Ex: *psi, kg/cm2*

Terms definitions and concepts from electricity

1. Electricity = any effect resulting from the existence of stationary or moving electrical charges.
2. Current (*I*) = a flow of electric charge through a conductor. The unit of current is the ampere (*A*).
3. Resistance (*R*) = opposition to the flow of an electrical charge. The unit of resistance is the ohm (Ω)
4. Volt (*V*) = the unit of electric potential difference.

Terms definitions and concepts from heat

1. Heat = the energy transfer from one object or system to another as a result of a difference in temp.
2. Temperature = a property that quantifies the relative heat of an object or region, usually expressed as °C, °F, or °K.
3. Thermodynamics = the study of the laws that govern the conversion of energy from one form to another

Terms definitions and concepts from chemistry

1. Chemistry = the study of matter.
2. Atom = the building block of matter, composed of protons (*p*+), neutrons (*n*), and electrons (*e*-).
3. Element = a substance that cannot be decomposed into more simple substances by ordinary means.
4. Molecule = two or more atoms joined together.
5. Compound = two or more elements joined together
6. Ion = an atom or group of atoms with an electrical charge.

Special Reference: 1.4 Fire Warning Equipment for Dwellings
Related References: None

Basic requirements for household fire alarms

1. Smoke alarm is stand alone self contained device
2. Single station smoke alarm cannot be interconnected
3. Multiple station smoke alarms can be interconnected
4. Most residential applications require electrical primary power with battery backup

Required protection for household fire alarms

5. New construction: require smoke alarms in each sleeping rm, outside each sleeping rm on each floor
6. Existing construction: require smoke alarms outside each sleeping rm, on each floor
7. Household smoke alarms shall be interconnected
8. New hotels, dorms, apts require smoke alarms in each sleeping rm and outside sleeping rms, interconnected
9. Existing hotels, dorms, apts require smoke alarms outside each sleeping room, interconnected
10. Lodging/rooming house require smoke alarm in each sleeping room, interconnection not required

Power supply & performance requirements

11. Smoke alarm standby battery required to power device for 7 days then 4 minutes in alarm
12. Smoke alarms with a rechargeable or replaceable primary batt shall operate 1yr / 7 day tbl / 4 min alarm
13. Household fire alarm system requires standby battery capable of 24 hrs normal operation, 4 min in alarm
14. 95% reliable: household fire alarm systems which: uses control panel, 2 power sources, all circuits are supervised, monitored, tested monthly
15. 90% reliable: household systems not monitored
16. 85% reliable: interconnected, unsupervised smokes

Spacing and location of detectors

17. Smoke alarms within 21' of sleeping rooms
18. Keep devices 3' away from baths / kitchens
19. Max of 18 unsupervised initiating devices can be interconnected (only 12 can be smoke alarms)
20. Max of 64 supervised initiating devices can be interconnected (only 42 can be smoke alarms)

Location of alarm sounding devices

21. Sleeping area audibles shall be at least 75 db. Sound level @ pillow: 15db above ambient, 5db above max

Special Reference: 1.5 Basic Individual Safety
Related References: None

Follow safety standards

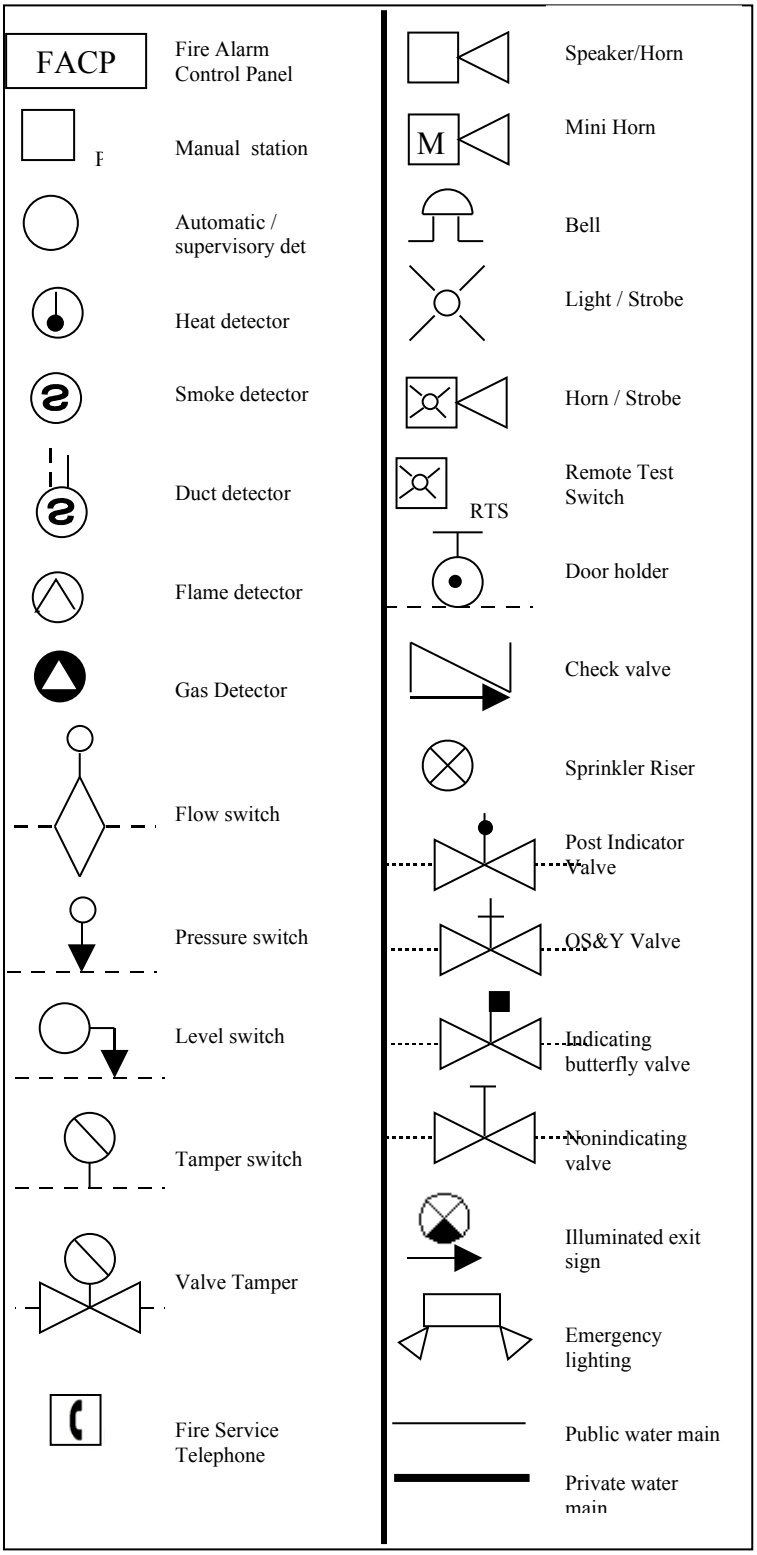
1. Stairs with 4 or more steps require handrails
2. Ladder steps shall be spaced at 12"between steps
3. Tops of step ladders shall not be used as steps
4. Ladders used to access roofs shall extend 3' above the point of ladder support on the roof
5. Minimum width of ladder stairs is 12 inches
6. Maximum single ladder length or section length is 30'
7. Ladders with 2 sections can extend to a max of 48'
8. Ladders with 3 sections can extend to a max of 60'
9. Extension ladders shall have a minimum section overlap of: 0'-36' = 3', 36'-48' = 4', 48'-60' = 5'
10. For ladders supported on a wall, place ladder at 1/4th of the working length of the ladder from wall
11. Scaffolds shall support a min of 4 times max load
12. Scaffold ends shall extend over at least 6" and not more than 18" over the end
13. Tube & coupler scaffolds shall be secured to the bldg every 30' horizontally and 26' vertically at the max
14. Scaffolds more than 10' AFF shall have guardrails
15. Hearing protection required when exposure exceeds: 90 dba for 8 hrs, 92 dba for 6 hrs, 95 dba for 4 hrs 97 dba for 3 hrs, 100 dba for 2 hrs, 105 dba for 1 hr
16. Employers shall have a hearing conservation program when exposure is 85dba for 8 hrs or more
17. Eye protection with side protection required when hazards from flying objects exist
18. Protective helmets required in areas w/falling objects
19. Protective footwear required in areas with a danger of foot injury from falling or rolling objects
20. Machine lockout required where injury could occur
21. When lockout cannot occur, tagout is acceptable
22. Employers must ensure 1st aid supplies are available
23. Workspace in front of electrical equip requires 30"
24. Extension cords shall not be used to raise equipment
25. Extension cords shall not be stapled
26. The grounding plug shall not be altered
27. 3 wire to 2 wire adapters shall not be used
28. Compressed air for cleaning shall not exceed 30 psi
29. Explosive actuated tools shall: be loaded only for immediate use, unattended tools shall be unloaded, tools shall not be left unattended, in case of a mis-fire wait 30 sec then refire, clear according to mftr

Special Reference: 1.6 First Aid Procedures
Related References: None

Basic rules and procedures for first aid

1. Follow the 3 C's for first aid
2. CHECK the scene and the injured person
3. CALL 911 or local emergency number for help
4. CARE for the injured person
5. Bleeding injury
   -Place dressing and apply direct pressure to the wound
   elevate above the heart unless there is a fracture
   -Apply pressure bandage directly over the dressing
   -If bleeding doesn't stop use pressure points
   Arm = brachial artery on upper arm bone
   Leg = femoral artery on pelvic bone
6. Poisoning signs: vomiting, heavy breathing, sudden onset of illness, burns / odors on mouth & lips also possible unusual behavior
   -Call local poison control center
   -Try to ID poison, inform poison center of type of poison, time & amount of ingestion, age of victim
   -Place victim on side and monitor pulse & breathing
   -Do not give anything by mouth
7. Shock signs, cool moist pale, bluish skin, weak rapid pulse, nausea, increased breathing, apathetic attitude
   -Have victim lay down in comfortable position
   -Control any external bleeding
   -Help victim maintain normal body temp, cover victim
   -Elevate legs 12" unless victim has broken legs, injured back/neck or injury to head
   -Do not give victim food or water
8. Burn signs, redness pain swelling blisters deep tissue damage, charred appearance
   -Stop the burning put out the flames remove the victim
   -Cool all burns, run cool water on burn or immerse
   -Do not cool electrical burns
   -Cover burn with a dry sterile dressing
   -Keep the victim comfortable
   -For chemical burns, flush w/ water until EMS arrives
9. Heat exhaustion signs pale clammy skin, profuse sweating, weak nausea, headache
10. Heat stroke signs hot dry red skin, no perspiration, rapid weak pulse, high body temperature (105+)
    -Get victim out of heat, loosen / remove sweat soaked clothing
    -Apply cool wet cloth and fan the victim
    -Give the victim cool water to drink

General Reference: 2.1 Fire Alarm Plans & Symbols
Related References: None



General Reference: 2.2 Basics of Systems Layout
Related References: None

Requirements for extents of protection

1. Total protection shall include detectors in all these areas: all rooms, halls, attics, storage areas, basements, above suspended ceilings, closets, elevator shafts, enclosed stairways
2. Partial protection shall include detectors in all these areas: all common areas, work spaces, corridors, lobbies, storage rooms, equipment rooms
3. Selective protection requires detectors in selected areas only & installation shall comply with NFPA 72
4. Supplementary (nonrequired) protection permits the limited installation of initiating devices without regard to spacing requirements. All other aspects of the fire alarm system shall comply with NFPA 72

Requirements for initiating devices

5. Pull stations shall be mounted 3.5' – 4.5' AFF
6. Maximum travel distance from any point in the bldg to the nearest pull station shall not exceed 200'
7. Pull stations are required at all exit doorways
8. Pull stations are required on each floor at the exit doorway
9. Fire alarm systems which use waterflow or automatic detector require at least 1 pull station located per AHJ
10. Group openings which exceed 40' require a pull station on each side of the group opening
11. Pull stations shall be located within 5' of the exit
12. All points on the ceiling shall have a detector within 0.7 times the listed spacing of the detector
13. Heat detectors have a listed spacing, ceilings over 10' in height require reduced heat det spacing
14. Smoke detector spacing is permitted to be 30'
15. 1 smoke det works for 30' x 30' room (900 ft^2)
16. Ceiling heights over 28' require engineering survey

Requirements for notification appliances

17. Audibles, 15db above ambient, 5db above maximum sound level with duration of 60 seconds or more
18. Public mode notification intended for all occupants
19. Private mode intended for emergency action persons
20. Strobes must meet minimum illumination requirements as detailed in NTC Brown Book Chap 6
21. Strobe requirements differ from ceiling mounted and wall mounted devices

General Reference: 2.3 Electrical Installation

Related References:	Basic Wiring	pg 3
	Basic Electricity	pg 6
	Installation Standards	pg 9
	Fire Alarm System Wiring	pg 50

NEC as it applies to fire alarm systems

1. Electrical wiring shall be done in a workmanlike way
2. Grounding is the connection of metal parts to ground
3. Bonding is the connection of all grounds together
4. Grounding electrodes shall be 3/8" in diameter and at least 8' in length
5. Follow the conduit fill charts Chuck Notes
6. Follow the box fill chart Chuck Notes page

NEC as it applies to connection w/ suppression sys

7. A fire pump power source shall be reliable electric utility or an on site power production facility
8. Fire pump supply conductors shall be supervised
9. Supply conductors shall be connected to the fire pump controller or a transfer switch
10. The fire pump disconnecting means shall be suitable, lockable, & marked Fire Pump Disconnecting Means
11. The location of the disconnecting means shall be listed at the fire pump controller
12. Pump running, start failure, and power failure shall initiate a supervisory signal
13. Remote control circuits shall be supervised
14. A fault on the circuits which connect a fire alarm panel to a suppression system shall not cause the suppression system to actuate

Requirements for power limited circuits

15. PLFA = Power Limited Fire Alarm (12 or 24 V)
16. PLFA requires insulation rated at 300 V
17. Min wire gauge for PLFA = 18 AWG single conductor or 26 AWG for multiconductor
18. Class 1 power limited = 30v max, power 1000va max
19. Class 2 circuit = 30v, 100va or 150v, .5va
20. Class 3 circuit = 150v, 100va

Requirements for nonpower limited circuits

21. NFPLFA = Non Power Limited Fire Alarm (120 V)
22. NFPLFA requires insulation rated at 600 V
23. Min wire gauge for NPLFA = 18 AWG
24. Class 1 remote control = 600v max, current unlimited
25. NPLFA circuits are permitted in the same raceway as class 1 circuits
26. NPLFA circuits require NEC Chap 3 wiring methods

General Reference: 2.4 Basic Fire Alarm Signaling Systems

Related References:	Basic Fire Alarm Systems	pg 1
	Local Systems	pg 32
	Auxiliary Systems	pg 33
	Remote Systems	pg 34
	Proprietary Systems	pg 35
	Central Station Systems	pg 36

The various types of fire alarm systems

1. Local systems do not communicate to monitoring
2. Proprietary systems, monitoring station and protected bldgs are all under one ownership
3. Remote station systems are the most common systems installed they communicate to a monitoring station which may be listed or not listed
4. Central station systems have specific listing, contracts and service requirements
   -Equipment, monitoring and installation shall be listed
   -Contract shall be between bldg owner and listed company
   -Service elements include testing, runner service, signal monitoring

Differences between coded and noncoded signals

5. Coded signals send several discreet bits of data
6. Noncoded signals send only 1 piece of data
7. Coded and noncoded signals are transmitted from devices to the control and from the control to the monitoring station
8. In old systems, the notification device would give a coded signal to indicate the specific device in alarm
9. Modern coded devices are addressable

Requirements for voice communications systems

10. Voice evac circuits shall be supervised
11. Voice evac systems are required for larger assembly & high rise occupancies
13. Voice evac systems require a fire command center
14. Primary power circuits shall be in located in limited combustible areas
15. Standby power 24 hrs / 15 min at max load
16. Multichannel capability may be required by AHJ
17. Multichannel permits evacuation for some zones and relocation instructions for other zones
18. The evac system shall respond to an alarm signal
    -2 cycles of the evacuation signal then evac message
    -Or alert tone of 6-10 seconds then the relocation message which is repeated at least 3 times

Requirements for evacuation systems

19. The internationally accepted evacuation signal is Temporal 3 or ANSI S3.41 signal

General Reference: 2.5 Supervision & Supervisory Service

Related References: Signal Transmission pg 43
Signal Processing pg 47

Terms for supervision and supervisory service

1. Supervision is the act of monitoring installation conductors for integrity. Faults = trouble signals
2. Supervisory service is the act of monitoring devices or persons for a normal status, off normal status generates a supervisory signal
3. Monitoring for integrity = supervision
4. Delinquency is the failure of a guard to check in at a station at a specific time period

Basic supervision requirements for fire alarm systems

5. A single open or a single ground shall indicate a trouble signal within 200 seconds
6. All means for interconnecting conductors, devices, equip, and appliances shall be monitored for integrity
7. A single open or single ground fault shall not generate an alarm nor interfere with alarm signals
8. An open, ground or short on one notification circuit shall not affect other notification circuits

Parts of the fire alarm system requiring supervision

9. All parts of the fire alarm system shall be supervised
10. There are some exceptions to supervision
    - -Noninterfering shunt circuits where a fault would only affect the noninterfering operation
    - -Connections to supplementary systems where the fire alarm system is not affected by a fault
    - -An alarm notification appliance in the same room as the control where all wiring is in conduit
    - -A trouble signal does not require supervision
    - -Interconnection between listed equip in an enclosure
    - -Interconnection between controls where the wire is in conduit and no longer than 20 feet

How electrical supervision is achieved

11. End of line resistor is used to supervise circuits, the control monitors the resistor, when a fault occurs the control loses sight of the EOLR
12. End of line diode is used with reverse polarity.

Types of supervisory service

13. Suppression system supervision & guard supervision

General Reference: 2.6 Detection Methods
Related References: Detector Spacing pg 23

The basic principles of heat detectors

1. Heat detectors have a listed spacing from UL / FM
2. Ceilings above 10' = reduced detector spacing
3. Fixed temp heat detectors are nonrestorable
4. Bimetallic heat detectors are restorable
5. Rate of rise detectors are restorable
6. Rate compensation detectors reduce thermal lag
7. Line type heat detectors shall be mounted within 20" of the ceiling
8. Heat detectors shall be rated 20º more than maximum expected temperature at the ceiling

The basic principles of smoke detectors

9. Smoke detectors do not have a listed spacing
10. Smoke detectors are permitted to be spaced at 30'
11. Ceiling height does not affect smoke spacing
12. Ceilings over 28' should have an engineering survey
13. Smoke detectors capable of field adjust sensitivity shall have range of not less than 0.6% / ft obscuration
14. Smokes are sensitive to adverse environments
15. Smoke detector operating temperature 32º-100º F
16. Smoke detector maximum humidity 93%
17. Smoke detectors maximum air velocity 300 ft/min
18. Photoelectric smoke = light scattering principle
19. Ionization smoke = uses radiation and measures current flow through air smoke reduces flow
20. Photobeam smoke = light obscuration principle
21. All points on the ceiling shall have a detector within 0.7 times the spacing (increase spacing in corridors)

Select the best detector for the application

22. Incipient stage of fire = Ionization det
23. Smoldering stage of fire = Photoelectric det
24. Flame stage of fire = Flame det
25. Heat stage of fire = Heat det

Select the best detector for the ambient conditions

26. Ionization detectors are affected by altitudes which are greater than 3000 ft above sea level
27. Photoelectric smoke detectors are affected by the color of smoke
28. Air sampling and photobeam detectors are affected by high humidity and temperature extremes

General Reference: 2.7 Detector Spacing
Related References: Detection Methods pg 22

Spacing requirements for heat smoke flame detectors

1. Normally 135º fixed temp heats listed for 50' spacing
2. Normally 190º fixed temp heats listed for 15' spacing
3. Normally rate of rise detectors listed for 50' spacing
4. Heat detector spacing reduced ceilings more than 10'
5. Smoke spacing permitted to be 30' by code
6. Ceilings greater than 28' require engineering survey for smoke detector spacing
7. Flame detectors are line of sight follow instructions
8. All points on the conveyer shall be in field of view

Spacing requirements for beam, aspiration detectors

9. Normally photobeam spacing is 60' between beams
10. Reduce photobeam length by 1/3rd when using mirrors (follow manufacturer's instructions)
11. Follow manufacturer's instructions for aspiration detectors and air sampling detectors
12. Each port on air sampling piping shall be considered a separate spot type detector

Spacing rules for irregular and high ceilings

13. Joists project from the ceiling more than 4" and are spaced 3' or less center on center
14. Beams project from the ceiling more than 4" and are spaced more than 3' center on center
15. Heat det reduce spacing 50% perpendicular to joists
16. Heat det reduce spacing 33% perpendicular to beams
17. For smoke det spacing joists = beams (same affect)
18. Ceiling with beam depth less than 10% of ceiling height 30' spacing shall be used
19. When beam depth = or greater than 10% & beam spacing = or greater than 40% of ceiling height, smokes are located on ceiling in every beam pocket
20. Waffle or pan type ceilings with beams no greater than 24"& spacing no greater than 12', 30' spacing shall be used. Locate on ceiling or on bottom of beam
21. A slope is more than 1 in 8
22. A shed slopes in 1 direction only
23. A peak slopes in more than 1 direction
24. 1st row of detectors shall be within 3' of the peak

Determine the appropriate quantity of detectors

General Reference: 2.8 Power Supplies
Related Reference: None

Requirements for primary power

1. Primary power shall be reliable, adequate and from a commercial light and power source or generator
2. Primary shall be a 2 or 3 wire supply and marked with "FIRE ALARM CIRCUIT CONTROL"
3. PLFA overcurrent protection shall not exceed 20 amp
4. Generator capacity must operate system under max load in addition to all other demands placed on it
5. Sufficient fuel shall be available for 6 months of test plus meet the standby requirements for the system
6. If a reliable source of fuel is within 2 hours, then the standby time for the generator can be reduced to 12 hr

Requirements for secondary power

7. Secondary batteries shall provide power to the system within 10 sec without loss of signals
8. Quiescent means non alarm
9. All commercial fire alarm systems require standby power for 24 hours / 5 minutes
10. Residential requires 24 hours / 4 minutes
11. Voice evac requires 24 hrs / 15 min under max load
12. The secondary power source shall be battery or auto start engine driven generator
13. Batteries shall be recharged within 48 hours
14. Dry cell batteries shall not be permitted
15. Emergency Systems: an engine driven generator system which provides power to bldg systems which have a direct affect on life safety (fire alarm system)
16. Legally Required Standby System: an engine driven generator which powers systems with indirect affect
17. Central station receivers use legally required standby
18. Generators require a separate start battery
19. A UPS shall be used for computers which receive or process fire alarm signals

Requirements for the trouble power supply

20. Trouble signals shall be indicated audibly & visibly. Today this is done with piezos and LEDs which have minimum current draw. In the old days, troubles were indicated by a lamp & bell…high current draw A separate power supply was required for this.

Calculate standby capacity requirements

21. NTC Brown Book Chap 8, Chuck notes NEC Sec

General Reference: 2.9

Related References: Periodic Testing pg 5
Fire Alarm System Maintenance pg 49

Requirements for acceptance testing

1. All new installations require acceptance testing
2. Acceptance testing should be conducted with the bldg owner, AHJ and installation company
3. A record of completion shall be done for all systems
4. Installer should test entire system prior to AHJ arrival
5. Inspection/testing form should be completed for acceptance testing

Procedures for acceptance testing

6. Prior to acceptance testing as built drawings should be completed indicating the actual installation
7. The AHJ may require a written statement of compliance prior to acceptance testing
8. The bldg owner shall be given as built drawings, owners manual, installation instructions, software
9. All installation wiring shall test free of opens, shorts and ground faults. The resistance shall be recorded
10. Parts 1 - 11 of the record of completion shall be filled out after the installation of system wiring
11. Part 12 - 13 shall be completed after operational acceptance testing is finished
12. Must meet testing & inspections per NFPA 72

Testing methods for various components

13. Waterflow switches shall be tested by flowing water from an orifice of the smallest size used on the system
14. Smoke detectors shall be tested by introducing smoke into the chamber of the device
15. Nonrestorable heat detectors shall be tested mechanically (on a rotating schedule) and electrically
16. Review NFPA 72, test methods table

Testing frequencies for various components

17. Test smokes within 1st year, then every other year
18. Test waterflow switches semiannually
19. Test supervisory devices quarterly except valve tampers test semiannually
20. Test all notification appliances annually
21. See Chuck Notes Testing Table for a complete list

Inspection frequencies for various components

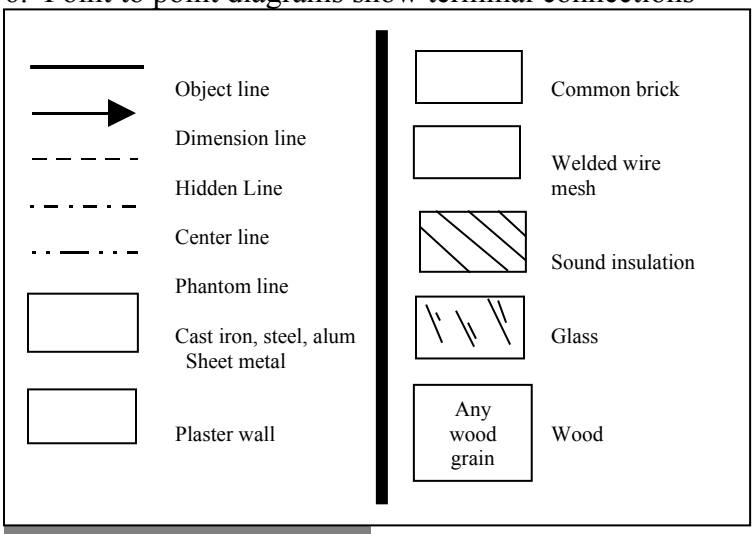
22. See Chuck Notes Inspection Table for a complete list
23. See NTC Brown Book

General Reference: 2.10 Construction Plans

Related References: Fire Alarm System Drawings pg 7
Plans & Symbols pg 17
Surveys for Fire Alarm Systems pg 48

Construction plan symbols & terminology

1. Site plans are "PLAN" view (from top) & to scale
2. Site plans include location of utilities & prepared by a certified land surveyor, include legend, north arrow
3. Contract drawings show planned location of equip
4. As built drawings show actual install locations
5. Riser diagrams show circuits, devices, # conductors
6. Point to point diagrams show terminal connections



Interpret plan information

7. Floor plan dimensions always refer to the actual size of the building regardless of scale
8. Scale refers to the ratio of the building dimensions to the dimensions of the drawing
9. Subdimensions must add up to the overall dimensions
10. Stairs are drawn with the number of stairs and an arrow to indicate up the stairway
11. The size and direction of joists and beams are listed in the notes section of the floor plans
12. Rooms are dimensioned from wall to wall without consideration of the thickness of the wall or covering

Read plans to determine obstructions & mechanical systems

13. Placement of mechanical & electrical systems can affect location of fire alarm devices
14. When doing contract drawings, have a reflected ceiling plan available
15. Pick up a blueprint text at any bookstore

General Reference: 2.11 Specifications & Costs
Related References: None

Interpret standard specifications related to fire alarm systems for general/mechanical conditions

1. There are 3 parts of the specification General Clauses, Technical Instructions, Acceptance of the System
2. Most specifications are software generated today
3. The fire alarm specifications are part of the contract documents which have 16 trade divisions as follows:

Division 1 General	Division 9 Finishes
Division 2 Site Work	Division 10 Specialties
Division 3 Concrete	Division 11 Equipment
Division 4 Masonry	Division 12 Furnishings
Division 5 Metals	Division 13 Special Cons.
Division 6 Wood & Plastic	Division 14 Conveying Sys
Division 7 Thermal & Moisture	Division 15 Mechanical
Division 8 Doors & Windows	Division 16 Electrical

4. Most specifications state the fire alarm system contractor is responsible for code compliance
5. Fire alarm contractor is responsible for meeting the requirements of the AHJ
6. The specification identify whether a conventional or addressable system is required

Determine the fire alarm requirements from HVAC mechanical & electrical parts of the specification

7. Fire alarm requirements can be found both Division 15 and 16
8. HVAC systems require a duct detector on the supply side when the unit is greater than 2,000 cfm
9. HVAC systems require a duct detector on the return side when the unit is greater than 15,000 cfm serving 2 or more floors

Interface requirements with other systems

10. When bldg has both duct detectors and a fire alarm system they shall be connected
11. Many occupancies require sprinkler systems to be connected to the fire alarm system (check NFPA 101)

Cost estimates as related to working drawings

12. Use drawing to determine quantity of devices
13. Review the reflected ceiling plans for obstructions

General Reference: 2.12 Contracts
Related References: None

Contractual relationships in the industry

1. Contract documents include all documents and graphics prepared by the architect and engineer
2. Project documents include the following
   - Bidding requirements
   - Contract forms such as the Agreement, Performance bond, Payment bond, Certificates
   - Contract conditions, general and supplementary
   - Specifications
   - Drawings
   - Addendum
   - Contract modifications
3. Project manuals include bidding requirements, contract forms, contract conditions, specifications
4. Bidding documents include the project manuals and drawings with the addendum
5. Construction documents include all of the contract documents listed above
6. The contract documents include all of the documents except the bidding requirements
7. The contract documents cover all phases of the construction project
8. Planning phase includes feasibility study, site analysis and site selection
9. Design phase includes preparation of schematics and drawings, and preparation of bidding documents
10. Bidding phase includes the addenda
11. Construction phase includes mobilization, administration and payment certificates
12. Post construction phase includes bldg occupancy, maintenance and warranty issues and records
13. Agreement: written contract between the bldg owner and the contractor to perform work
14. Performance bond: provides protection for the owner
15. Payment bond: provides protection for the labor force and the suppliers
16. Certificates: includes insurance certificates and certificates of compliance with codes
17. General conditions: clauses that establish how a project is to be administered
18. Specifications: define qualitative requirements
19. Drawings: a graphic representation of the work
20. Addenda: additions and changes made from bidding

General Reference: 2.13 Building Codes
Related References: None

Building codes and their enforcement

1. Bldg codes ID which use groups require fire systems
2. Building codes establish the minimum requirements
3. There used to be several organizations producing a bldg code ICC, ICBO, SBCCI, BOCA
4. Now they have been combined into 1 group, ICC which produces the International Bldg Code (IBC)
5. Building codes are based on NFPA 101 requirements

Difference between building codes and installation standards

6. The building code is used to determine which use groups and occupancies require the installation of fire alarm equipment
7. The bldg code identifies which bldgs require smoke detection, pull stations voice evac and monitoring
8. The Installation standard (NFPA 72) is used to determine how to install fire alarm equipment spacing mounting heights & performance criteria information
9. First consult the building code to determine if a fire system is required then NFPA 72 for installation req

Fire alarm system requirements according to the building codes

10. The following use groups require fire alarm systems

Group E	High Rise
Group I	Special Amusement
Group I-2	Aerosol Storage Uses
Group R-1	Lumber Mills
Group H-5	Underground bldg w/smoke exhaust system
Atriums serving 2 floors	Residential Aircraft Hanger
High Piled Combustible storage	Air Traffic Control Tower
Use of delayed egress	Battery Rooms

11. The following use groups may require a fire system

Group A	Group M
Group B	Group R-2
Group F	Underground buildings
Group I-3	Covered Malls

12. Groups R-2, R-3, R-4 and I-1 do not require systems

General Reference: 2.14 Insurance Authorities
Related References: None

Requirements of Factory Mutual

1. Factory Mutual is now called FM Global
2. FMRC (now FM Global) tests equipment to standards
3. FMI (now Protection Mutual) helps policy holders protect their property
4. Protection Mutual primarily insures industrial and institutional facilities
5. FM Global provides an approval standard for Central Station Service identified by class number 3011
6. Class #3011 follows NFPA 72 with a few exceptions
    - Alarm signals: dispatch a runner to arrive within 1 hour if equipment needs to be reset
    - Delinquency signals: dispatch a runner to arrive within 30 minutes
    - Supervisory signal: notify subscriber within 4 minutes, dispatch runner to arrive within 4 hours
    - Trouble signal: notify subscriber within 4 minutes, dispatch runner to arrive within 4 hours
    - Central monitoring station requires 60 hrs of standby power

Requirements of Industrial Risk Insurance

7. IRI no longer exists now they're GE Asset protection
8. IRI developed data sheets and interpretive guides for fire alarm equipment and NFPA standards
9. IRI requirements followed NFPA 72, UL and some of their own requirements
10. IRI developed surveillance levels for fire protection
11. Level 1: waterflow alarm service or local waterflow with watchman service
12. Level 2: complete alarm & supervisory service or watchman service & waterflow on local panel
13. Level 3: complete alarm & supervisory service or watchman service & waterflow on local panel, waterflow signals must be transmitted
14. Level 4: bi hourly watchman service with alarm service actuation from sprinkler system

Requirements of Insurance Service Office

15. ISO evaluates city fire protection for insurance rates

General Reference: 2.15 Governmental Agencies
Related References: None

Special requirements for department of defense

1. Government Service Administration (GSA) follows requirements of NFPA 72 & requires NICET II
2. Contractor must provide training certificates
3. All workers must have clearance & issued access pass
4. All fire alarm systems shall be tested IAW NFPA 72

Special requirements for Veterans Administration

5. The VA follows the requirements of NFPA 72 & 101
6. The VA always uses the most current edition of codes
7. The VA does not recognize ADA requirements but follows the Uniform Federal Accessibility Standard
8. The VA classifies fire system requirements into 3 categories for notification
   - Health Care Positive alarm sequence
   - High Rise Positive alarm sequence
   - Other General alarm
9. Combination systems shall not be permitted
10. Wiring shall comply with the following
    - Initiating circuits Class B, Style B
    - SLC circuits Class B, Style 4.0
    - NAC circuits Class B, Style Y
    - Comm between bldg Class A, Style 7
11. All VA systems require monitoring, elevator recall & shutdown, close smoke doors on alarm floor, open locked egress doors and disconnect fuel from stoves
12. UFAS requires 1 sleeping room out of 25 be provided with strobes for handicapped persons
13. Elevator circuits should be set up as follows
    - 1st Circuit = Phase 1 = elevator lobby detectors
    - 2nd Circuit = Phase 1 = machine room detectors
    - 3rd Circuit = Phase 2 = active fireman's hat light in elevator car when alarm occurs in the hoistway or machine room

Relationship of government requirements to national standards

14. Governmental agencies follow the national codes
15. Govt agencies in some cases exceed the codes

Prepare shop drawings for governmental agencies

16. Follow standard submittal requirements

General Reference: 2.16 Protective Premises Fire Alarm Systems

Related References: Basic Fire Alarm Systems pg 1
Basic Fire Alarm Signaling Systems pg 20

Requirements for local fire alarm systems

1. Combination systems shall be permitted
2. Interconnection of control units shall be permitted
3. Fire alarm signals have priority & shall be distinctive
4. Fire systems with waterflow or automatic detectors require at least 1 pull station located per AHJ
5. All fire pump signals shall be supervisory signals
6. Each floor of the bldg requires at least 1 NAC device
7. Class A provides 2 paths (4 wire) for signal transmission, Class B provides only 1 path (2 wire)
8. Class A w/single fault = All devices work
9. Class B w/single fault = devices up to fault work
10. Class A circuits are considered to be most reliable
11. There are 3 styles of class A SLC. Best is Style 7, then Style 6, then Style 4

Purpose of local systems

12. The primary purpose of local systems is evacuation
13. No signals shall be lost or delayed more than 10 sec
14. Signal priority is Alarm, Supervisory, Trouble

Types of signaling service available

15. Coded signaling conveys several discreet bits of data
16. Coded signals may be produced by a bell to indicate alarm and floor of origin where each floor has its own coded signaling sound
17. Coded signals: Alarm = 3 rounds, Supervisory = 2 rounds, Trouble = 1 round
18. Noncoded signals indicate alarm condition only
19. Protective premises systems may be connected to Auxiliary, Proprietary, Remote or Central stations

Power supply requirements (primary & standby)

20. Primary power shall be dedicated branch circuit
21. Standby power requirements = 24 hrs / 5 min

Requirements for supervision & signal appliances

22. All installation conductors shall be supervised
23. Sprinkler system operations shall be supervised
24. Evacuation signal is ANSI S3.41 = Temporal 3
25. Evac signals in 1 zone shall be synchronized

Requirements for signal capacity of circuits

26. Max devices per zone: waterflow = 5, supervsry = 20

General Reference: 2.17 Auxiliary Fire Alarm Systems

Related References: Basic Fire Alarm Systems pg 1
Basic Fire Alarm Signaling Systems pg 20

Concept of auxiliary fire alarm systems

1. Auxiliary systems tie into municipal street boxes for communications to monitoring, not phone lines
2. When an alarm signal is actuated, the panel trips the municipal street box, the signal is the same as the box

Purpose of an auxiliary fire alarm system

3. Auxiliary systems provide fire dept notification

Types of auxiliary fire alarm systems

4. Local energy = electrically isolated from the municipal fire alarm circuits and systems
5. Shunt = electrically connected to municipal system

Requirements for auxiliary fire alarm systems

6. Auxiliary systems shall not require audible devices
7. Local energy systems can be coded or noncoded
8. Local energy systems may be connected to wired, radio or telephone series street boxes
9. Shunt system actuating devices shall be noncoded
10. Shunt systems require the following
    - Shunt systems shall not be connected with a relay
    - 1 auxiliary transmitter can serve 100,000 ft^2
    - Shunt systems shall not use automatic detectors
    - Shunt systems shall only be connected to a coded wired municipal street box
11. Transmitter (box) may only serve 1 bldg unless AHJ approves / permits multiple buildings per box
12. Personnel acting as operators shall comply with NFPA 1221, and NFPA 72 Chapter 9

Wiring requirements for auxiliary fire alarm systems

13. A single fault shall not affect municipal system or cause a false alarm signal to be sent
14. Conductors shall be in conduit (both in the same one)
15. Minimum conductor size is 14 AWG
16. Max shunt loop length is 750 feet

Power requirements for auxiliary fire alarm systems

17. Standby power = 24 hrs / 5 minutes in alarm

Signaling service available to auxiliary systems

18. Auxiliary systems can only send alarm signals
19. Supervisory signals cannot be sent

General Reference: 2.18 Supervising Station Fire Alarm Systems

Related References: Basic Fire Alarm Systems pg 1
Basic Fire Alarm Signaling Systems pg 20

Concept of remote station fire alarm systems

1. Remote station systems are designed to send signals to a monitoring facility, they retransmit to fire dept
2. The monitoring station shall be approved by the AHJ
3. Remote station systems do not require runner service

Purpose of remote station fire alarm systems

4. The primary purpose of remote station fire systems is to provide notification to responding authorities
5. Remote station systems do not require notification appliances by NFPA 72 but other codes may

Requirements for remote station system operation

6. Remote station systems shall automatically provide audible & visible indication of alarm, sup, & tbl
7. Signal receipt shall be conducted by trained persons
8. Access to the remote station shall be limited per AHJ
9. The remote station shall have 2 or more operators
10. Upon receipt of signals, the operator shall notify the owner or designated representative
11. Retransmission of signals shall occur by:
    - Dedicated circuit
    - 1 way telephone
    - Private radio system using fire dept frequencies
    - Other methods accepted by the AHJ
12. All controls shall be operated at the change of shift
13. The status of all signals shall be noted and recorded
14. A permanent record of all signals shall be maintained for at least 1 year

Power supply requirements for remote station

15. Remote station systems shall have a standby power supply capable of 24 hrs in normal ops, 5 min alarm
16. The remote monitoring station shall have standby power capable of 24 hrs of operations

Types of signaling service available

17. NFPA 72 does not require remote station systems to use notification appliances of any kind
18. Other codes (NFPA 101) may require the use of notification appliances
19. Remote station systems shall provide alarm signals, supervisory signals and trouble signals
20. Runner service is not required for remote station sys

General Reference: 2.19 Proprietary Station Fire Alarm Systems

Related References: Basic Fire Alarm Systems pg 1
Basic Fire Alarm Signaling Systems pg 20

Concept & purpose of proprietary station systems

1. The protected bldg and monitoring station are under the same ownership (college campus, prison)
2. Provide direct control to the bldg owner and a higher level of fire protection (runner service is required)

Requirements for proprietary system operations

3. The monitoring station shall be located in a fire resistive detached bldg
4. Access to the monitoring station shall be restricted
5. The monitoring station shall have fire extinguishers and emergency lighting with 26 hr battery backup
6. If the monitoring station serves 25 or more bldgs
   -Signals shall be received / recorded automatically
   -The monitoring station shall have a telephone
7. The zone of origin shall be designated at the protected bldg or the monitoring station or both
8. The monitoring facility shall have 2 recording devices
9. At least 2 operators shall be on duty at all times (1 of the operators may also serve as a runner)
10. Upon receipt of an alarm signal, a runner shall be dispatched to arrive at the protected bldg within 2 hrs
11. Upon receipt of a supervisory signal a runner shall be dispatched to arrive at the protected bldg within 2 hrs
12. Upon receipt of a trouble signal a runner shall be dispatched to arrive at the protected bldg within 4 hrs
13. Delinquency signal shall require dispatch of a runner to arrive at the guard tour station within 30 minutes
14. Two way communication at 15 minute intervals is required for proprietary station systems

Power supply requirements

15. Protected bldgs: 24 hours / 5 minutes
16. Monitoring station: requires standby for 24 hours

Requirements for signal transmission

17. Signals shall designate bldg of origin
18. Alarm signal shall be received and recorded in 90 sec

Requirements for circuits and retransmission

19. Immediate retransmission required: within 90 sec

Types of service available

20. Alarm, supervisory, trouble, guard tour

General Reference: 2.20 Central Station Fire Alarm Systems

Related References: Basic Fire Alarm Systems pg 1
Basic Fire Alarm Signaling Systems pg 20

Concept & purpose of central station systems

1. Concept: provide a higher degree of reliability thru requiring specific service elements and inspections
2. Purpose: Insurance driven to reduce risk of loss

Requirements for central station operations

3. The prime contract shall provide 6 service elements
   -Installation of fire alarm transmitters
   -Signal monitoring
   -Retransmission of signals
   -Associated record keeping and reporting
   -Testing & maintenance of fire alarm equipment
   -Runner service for all signals
4. Installation of fire alarm equipment shall be certificated and placarded ($20"^2$) within 36" of control
5. The central station shall meet the requirements of ANSI / UL 827
6. The central station shall have 2 operators on duty
7. All test signals shall indicate date, time and type
8. Upon receipt of an alarm signal, the runner shall be dispatched to arrive at the protected bldg within 2 hrs
9. Upon receipt of a supervisory signal a runner shall be dispatched to arrive at the protected bldg within 2 hrs
10. Upon receipt of a trouble signal the runner shall be dispatched to arrive at the protected bldg within 4 hrs
11. Upon receipt of delinquency signal a runner shall be dispatched to arrive at the guard station within 30 min

Standby power supply requirements

12. Fire alarm equip at the protected bldg: 24 hrs / 5 min
13. Central station: requires standby capable of 24 hrs

Transmission requirements for central station

14. Central station facilities require 2 independent means of retransmission of signals
15. Using 911 for retransmission is not acceptable
16. Retransmitted signals and their time and date shall be recorded at the central station
17. If the public communications center is not equipped to acknowledge each fire alarm report, both means for retransmission shall be used

Types of signaling service

18. Alarm, supervisory, trouble, guard tour

General Reference: 2.21 Manual Fire Alarm Systems
Related References: Devices and Components pg 4

Mounting & location requirements

1. Mounting height such that the actuator is not less than 3.5' and not more than 4.5'
2. Locate so they are unobstructed within 5' of doorway
3. Locate at all required exits and on all floors
4. Max travel distance to the nearest pull station shall not exceed more than 200'
5. Group openings over 40' wide shall have a pull station located on each side of the doorway
6. Pull stations shall be located in the normal exit path

Use and operation of combination boxes

7. Our research has indicated combination boxes are no longer manufactured
8. NFPA 72 permits the use of combination boxes
9. The use of these were to provide 1 box for fire alarm signaling and supervision of guards
10. The guards performed fire watch, so this combination made sense

Requirements for guard's tour service

11. Guard tour stations shall be listed for the purpose
12. NFPA 601 details guard tour station requirements
13. Guard tour routes can use both transmitting and nontransmitting stations
14. Transmitting station intervals shall not be less than 10
15. Routes which have some non transmitting stations shall operate only in a fixed sequence
16. Distinctive start and end signals are required
17. Delinquency signals shall be transmitted if guard fails to actuate a box within 15 minutes of schedule
18. For guard tour periods over 24 hrs, a start signal shall be sent at least every 24 hours

Layout a manual / guard tour system

19. Follow requirements of NFPA 72 & 601

Operating principles of pull stations

20. Single station pull stations require 1 action to actuate
21. Double action stations require 2 actions to actuate
22. All pull stations in a bldg shall be of the same type
24. Pull station covers only permitted on single action
25. Pull stations shall actuate with 2 or less actions

General Reference: 2.22 Heat Sensing Fire Detectors

Related References:	Devices and Components	pg 4
	Detection Methods	pg 22
	Detector Spacing	pg 23

Principles of fixed temperature heat detectors

1. Detector responds when temperature reaches threshold
2. Typically 135º detector has a listed spacing of 50' and 190º detector has a listed spacing of 15'
3. Fusible link detectors use solder to hold spring, when solder melts at threshold, spring closes contacts
4. Bimetallic uses 2 metals which expand at different rates causing 1 metal to bend and closes contacts
5. Fusible link is nonrestorable, bimetallic is restorable

Principles of rate of rise heat detectors

5. Rate of rise responds with 15º rise per minute
6. Uses a flexible metal diaphragm, when air temp rises rapidly air expands pushing diaphragm into contacts
7. Rate of rise is self restoring, normal listing is 50'

Principles of rate compensation detectors

8. Rate compensation detectors compensate for thermal lag by responding when air temp reaches threshold
9. A tubular metal case extends when heated and closes a set of contacts and is self restoring

Principles of combination heat detectors

10. Combination heat detectors employ a fixed temp with rate of rise, usually listed of spacing of 50'

Temperature classifications for heat detectors

11. Heat detectors are color coded so when they are mounted the heat range is visible from the floor

100-174º F (39-79º C)	Uncolored
175-249º F (80-121º C)	White
250-324º F (122-162º C)	Blue
325-399º F (163-204º C)	Red
400-499º F (205-259º C)	Green
500º F (260º C) and up	Orange

Requirements for smooth and irregular ceilings

12. Heat detector spacing shall be reduced for ceilings which are more than 10' (Chuck Notes Chap 5)
13. Irregular ceiling requirements (Chuck Notes Chap 5)

How thermal lag affects detector response

14. Thermal lag = time for det to reach air temp

General Reference: 2.23 Smoke Sensing Fire Detectors

Related References:	Devices and Components	pg 4
	Detection Methods	pg 22
	Detector Spacing	pg 23

Principles of operation for ionization detectors

1. Ionization detectors use radioactive material to ionize the air in the measuring chamber
2. Altitudes greater than 3000' can affect ionization det

Principles of operation for photoelectric detectors

3. Photoelectric operate on principle of light scattering
4. Light is pulsed into the smoke chamber, when smoke is present the light is scattered on a photosensitive cell
5. The color of smoke can affect photoelectric detectors
6. Photobeam detectors operate on light obscuration
7. Smoke blocks the beam causing an alarm

Principles of operation for aspiration detectors

8. Aspiration detectors are very specialized & expensive
9. Uses air sampling network piping in protected area
10. The control analyzes air for signature of smoke
11. Commonly used in clean rooms & computer rooms
12. Uses a laser or high intensity strobe to detect smoke

Principles of operation for cloud chamber detectors

13. Cloud chambers use a humidification process
14. Water droplets form on smoke particles and light is used to detect concentrations of smoke particles
15. This is an older technology not frequently used

Stratification affects for smoke detectors

16. Stratification most commonly occurs on high ceilings
17. The smoke cools as it rises & as it gets cooler it stops rising sometimes at levels far below the detectors
18. It is recommended that detectors be located at 2 levels, on the ceiling and at least 3' below the ceiling
19. Photobeam / aspiration det are used on high ceilings

Layout of a smoke detection system

20. Smoke detector spacing permitted to be 30'
21. Ceiling height does not affect smoke detector spacing
22. High ceilings (above 28') require engineering survey
23. Reduce spacing 50% perpendicular to beams

Employ smoke detectors for door release

24. When distance from door to ceiling exceeds 24" 2 detectors are required, 24" or less only 1 detector
25. Door release detectors shall be listed for door release

General Reference: 2.24 Radiant Energy Sensing Fire Detectors
Related References: None

Principles of operation for infrared detectors

1. Infrared detectors use IR sensitive photovoltaic cell
2. The infrared wavelength range is 0.76-220 microns
3. Typical IR detectors respond to specific wavelengths in the 2.5-2.8 microns and 4.2-4.5 microns)
4. Filters are used to screen out other wavelengths
5. Flame flicker components may be added in the 5-30 Hertz range to reduce nuisance alarms
6. IR detectors respond best to hydrocarbon fires
7. Viewing angle is 15-170, direct view is best

Principles of operation for ultraviolet detectors

8. Ultraviolet detectors use a solid state sensor or a gas filled tube as a sensing element
9. Detection is in the 0.17-0.30 micron energy range
10. UV detectors are basically immune to sunlight and artificial light sources & can be used outdoors
11. UV detectors respond well to most fires
12. Arc welding can cause UV detectors to false alarm
13. Requires viewing window of quartz, not glass because glass cannot pass UV light
14. Typical viewing angle is 90-170º

Spacing requirements for flame detectors

15. Flame detectors should be installed and spaced according to the manufacturer's instructions
16. Normally an engineering survey done by a fire protection engineer supports use of flame detectors
17. Some important considerations in location & spacing
    -Size of the fire to be detected
    -Fuel involved
    -Sensitivity of the detector
    -Field of view of the detector
    -Distance from the detector to the fire
    -Radiant energy absorption of the atmosphere
    -Presence of extraneous sources of radiant emissions
    -Purpose of detection system
    -Response time required
18. Design shall specify size of flaming fire and the fuel
19. Detector viewing windows shall be kept clean

Parameters for indoor and outdoor use

20. Potential problems for indoor use include xrays, gamma rays, cosmic rays, arc welding, EMI/RFI

General Reference: 2.25 Sprinkler Waterflow and Supervisory Devices
Related References: Devices and Components pg 4

Operation of sprinkler alarm devices

1. Waterflow shall be an alarm signal
2. For wet pipe systems a waterflow switch is installed in the sprinkler riser
3. Alarm activation shall occur within 90 seconds of waterflow from the smallest orifice (inspectors test)
4. For dry pipe systems a water pressure switch is used which is required to operate with +/- 10 psi change

Operation of sprinkler supervisory devices

5. Sprinkler system supervisory devices typically monitor the position of control valves.
6. Control valves are normally open to allow waterflow
7. When the valve is closed no water can flow
8. Outside Stem & Yoke (OS&Y) and Post Indicator Valve (PIV) shall send supervisory signal within 2 revolutions of the wheel or 1/5th the travel distance
8. Air pressure supervisory used with dry pipe systems
9. A change of +/- 10 psi shall send supervisory signal
10. A restoral signal shall be sent when device resets
11. Water temperature supervisory shall indicate at 40º
12. Water level supervisory shall indicate w/ 12" change

Interconnection requirements of devices

13. Alarm & supervisory devices shall zoned separately
14. Supervisory signals shall be distinct from troubles
15. No more than 5 waterflows on any single zone
16. No more than 20 supervisory device on a zone

Code requirements for sprinkler devices

17. Control units shall be listed for waterflow service
18. Maximum retard on waterflow is 90 seconds
19. Waterflows used for elevator recall are not permitted to use a retard to delay signals
20. Piping shall be galvanized or non ferrous metal
21. Minimum piping size is 3/8"
22. Water movement due to waste surges or pressure changes shall not initiate an alarm signal

Fire pump requirements

23. All fire pump signals shall be supervisory signals
24. Fire pumps shall be supervised for start, fail to start, phase reversal, power fail & send supervisory signals
25. Maintenance should respond to fire pump signals

General Reference: 2.26 Alarm Notification Appliances

Related References: Basic Fire Alarm Systems pg 1
Devices and Components pg 4

Principles of operation for audible appliances

1. Audible device nameplates shall include performance and electrical characteristics
2. Public audible min sound level 15 db above average ambient sound or 5 db above max lasting 60 sec plus
3. Maximum sound level is 120 db
4. Sound measurements shall be taken at 5' AFF
5. Voice intelligibility required for voice evac systems
6. Private mode audibles shall sound at 10 db above average ambient & 5 db above max, 60 sec +
7. Audibles in elevators or bathrooms shall meet private mode requirements

Principles of operation for visible appliances

8. Minimum visible flash rate is 1 flash per second
9. Maximum visible flash rate is 2 flashes per second
10. The maximum flash pulse duration is 0.2 seconds
11. Visible appliance lens color shall be clear or white
12. Maximum illumination intensity is 1000 candella
13. Visible devices shall be of a type, size and located so they will be viewable from any orientation

Select specific types of appliances for various apps

14. NFPA 101 and the building code determine the type of notification required for various occupancies
15. High rise occupancies require voice evac
16. Assemblies greater than 300 require voice evac
17. Most occupancies require audibles in public areas
18. If visible devices are used audible devices can be reduced or eliminated with permission of AHJ
19. Usually more private areas like bathrooms require visible notification appliances

Spacing requirements for audible/visible appliances

20. Audibles shall be mounted so the top is 90" or more AFF and at least 6" down from the ceiling
21. Ceiling mounted audibles are permitted
22. Visible appliances shall be mounted so that the entire lens is 80" AFF or greater & not more than 96"
23. Synch required, more than 2 visibles in field of view
24. Strobes 15' from end of corridors & spacing = 100'
25. Nonsquare rooms use square that covers entire room

General Reference: 2.27 Basics of Signal Transmission

Related References: Supervision and Supervisory Service pg 21
Signal Processing pg 47

Types of signaling circuits used for fire systems

1. Fire alarm signals may be transmitted over copper, fiber optic cable, and by wireless means
2. Copper circuit transmission is by far the most popular
3. Signal transmission includes sending the signal from a device to the control then to NAC devices and CS
4. IDC = initiating device circuits, commonly referred to as conventional fire alarm circuits
5. SLC = signaling line circuits, commonly referred to as addressable or data circuits
6. NAC = notification appliance circuits, commonly referred to as NACs are for visible & audible devices
7. Class A circuits are capable of alarm during a single open or ground fault commonly called 4 wire circuit
8. Class B circuits shall be capable of alarm up to the point of a single open or ground fault (2 wire circuits)
9. Class A circuits offer higher reliability than Class B
10. The decision to use Class A circuits is determined by job specifications when higher reliability is desired
11. IDC circuit = Conventional initiating device circuit
12. SLC circuit styles = 4, 6, or 7
13. NAC circuit = Notification Appliance Circuit

Types of signals transmitted over fire circuits

14. Fire alarm systems are required to provide 3 distinct types of signals Alarm, Supervisory, Trouble
15. The time delay from alarm to activation of fire safety functions & notification shall not exceed 10 seconds
16. Alarm, supervisory & trouble signals shall be audibly and visibly distinct
17. Coded alarm signals shall consist of 3 rounds
18. Coded supervisory signals shall consist of 2 rounds
19. Temporal 3 is the accepted notification signal

Limitations on capacity of signaling circuits

20. Max of 5 waterflows permitted on 1 circuit or zone
21. Max of 20 supervisory devices per circuit or zone
22. Max loading capacity for McColloh circuits is 250 devices per transmission channel
23. Type 1,2, & 3 systems are active multiplex
24. Type 4 & 5 systems are 2 way RF multiplex radio
25. Type 6 & 7 systems are 1 way RF systems
26. Type A systems exceed 2500 signals per year
27. Type B systems send signals direct to fire station

Special Reference: 2.1 Emergency Voice / Alarm Communication

Related References:	Devices and Components	pg 4
	Alarm Notification Appliances	pg 42
	Evacuation Signals	pg 51

Purpose of voice evacuation systems

1. The purpose of a voice evacuation system is provide occupant notification of a fire
2. Large bldgs, bldgs with higher populations and high rise are where voice evac systems are typically used
3. Voice tends to generate less panic than evac signals
4. The bottom line is life safety for voice evacuation

Code requirements & operation for voice evac

5. Notification zones shall be consistent with evac zones
6. A single NAC circuit shall serve one notification zone
7. A fault on 1 NAC shall not affect other NAC circuits
8. Voice systems shall provide automatic (prerecorded) or live voice instructions
9. Speaker and 2 way phone circuits shall be supervised
10. Bldgs which require emergency voice systems shall have a designated command center
11. Automatic response to alarm signals shall be required
12. Selective/all call control required at command center
13. Multichannel capability shall be provided when this functionality is required by the AHJ
14. Multichannel is the ability to evacuate certain zones at the same time provide voice instructions to others
15. Alarm initiation shall result in the transmission of voice message followed by ANSI S3.41 evac signal, an alert tone (3-10 sec)followed by the voice message repeated 3 times, evacuation signal in the alarm zone
16. If the voice message fails the evac signal shall sound
17. Live voice instructions shall take precedence
18. The fire command center shall be clearly identified
19. Speakers shall meet minimum audibility requirement

Power requirements for voice evacuation systems

20. Voice evac systems shall have standby power supply capable of 24 hrs normal ops & 15 min at max load

Survivability requirements for voice evac sys

21. Bldgs with a voice evac system shall have a command center located at the entrance
22. Command center shall have restricted access, clearly marked controls, restricted access and comm. Equip
23. Control equip shall be located in a 1 hr fire resistive area with 3’ clearance & NAC protected by 2 hr area

Special Reference: 2.2 Signal Processing

Related References: Supervision and Supervisory service pg 21
Signal Transmission pg 43

Signal processing from the initiating device, to the control and to the notification appliances

1. Signal processing is the dynamic link between signal input and system response
2. Manual signals may result in evac or voice messages
3. Manual signals from street boxes go to the fire dept
4. Manual signals from remote station systems central station systems and proprietary systems are processed at a supervising station
5. Smoke and heat detectors can be on the same circuit
6. Automatic detectors on a local system shall result in the evacuation signal
7. Automatic detectors for commercial fire alarm systems are required to be latching
8. Automatic detectors for residential fire alarm systems are permitted to have nonlatching circuits
9. Guard tour signals are initiated mechanically w/ a key
10. Guard tours shall transmit a start and end signal
11. Intermediate non recording guard tour stations shall operate in a fixed succession
12. Exception reporting occurs when guard tour boxes are operated out of sequence
13. Delinquency reporting occurs when a guard fails to activate a station within the time window
14. For sprinkler systems waterflow and water pressure signals are always alarm signals
15. The following are supervisory signals, control valve, air pressure, water temp, water level fire pump signals
16. Fire sys shall indicate alarm, sup & trouble signals
17. Auxiliary systems are only capable of sending alarm signals they cannot send supervisory or tbl signals
18. Fire alarm systems shall identify a single open or ground fault as a trouble condition

Basic schematics for noncoded & coded fire systems

19. Coded systems use the following sequence

4th floor	2-4
3rd floor	2-3
2nd floor	2-2
1st floor	2-1
Basement	3-1
Sub basement	3-2

Special Reference: 2.3 Surveys for Fire Alarm Systems

Related References: Drawings pg 7
Symbols pg 17
Construction Plans pg 26

Determine requirements for property surveys

1. Surveys always start w/ requirements from NFPA 101
2. The life safety code specifies fire alarm system requirements for bldg types (occupancies)
3. Occupancies may require total, partial or selective coverage of areas within the bldg
4. Total coverage shall include all rooms, halls, attics, storage, basements, above suspended ceilings, closets, elevator shafts and enclosed stairways
5. Partial coverage shall include all common areas, work spaces, corridors, lobbies, storage rooms, equip rooms
6. Selective coverage = detection in selected areas with detectors installed in accordance with NFPA 72
7. Supplementary (Nonrequired) coverage provides fire detection in bldgs where a fire system is not required
8. Nonrequired systems shall meet all code requirements except spacing requirements for initiating devices

Determine best automatic det for the application

9. Smoke detectors shall be used in environmentally controlled areas
10. Smoke det shall be used temps from 32-100º F
11. Smoke det shall be used in 93% humidity or less
12. Air velocity greater than 300 ft/min affects smoke det
13. Smoke det spacing is permitted to be 30 ft
14. Photoelectric smokes are most common but certain environ affect performance, smoke color, humidity
15. Photobeams are used for higher ceilings or large area
16. Aspiration systems may be used in unusual situations where normal detection is not appropriate like high ceilings, high air movement or very early detection
17. Ionization smokes are used for early detection but are affected by altitude greater than 3000 feet
18. Heat detectors should be used in areas which are not appropriate for smoke detectors
19. Heat detectors have a listed spacing issued by UL
15. Higher ceilings require reduced heat det spacing
16. Normally combination rate of rise fixed temp heat detectors are used

Determine best notification for the application

17. Voice evac for high rise, large bldg populations
18. Horn/strobes used for general evac
19. Strobes generally considered better than horns

Special Reference: 2.4 Fire Alarm System Maintenance

Related References: Testing pg 5
Acceptance pg 25

Requirements for maintaining a fire alarm system

1. System defects shall be corrected at the end of testing
2. If defects cannot be corrected within 24 hrs the bldg owner shall be notified
3. The owner is responsible for complying with testing requirements and maintaining the system, delegation shall be in writing
4. Service personnel shall be qualified as demonstrated by NICET or state certified, or factory trained
5. Prior to testing or servicing the system notification should be made to occupants and monitoring station
6. Discharge testing suppression systems is not required
7. Acceptance testing shall be done for all fire systems
8. Reacceptance testing required when components are added or deleted or changes occur to hardware or site specific software
9. 100% of affected components shall be tested
10. 10% of non affected initiating devices shall be tested

Tests to determine device operability

11. Smoke detector functional tests shall be performed by smoke actually entering the smoke chamber
12. Non restorable heat detectors shall be tested both functionally and electrically
13. Ground fault tests shall be conducted by grounding any installation conductors
14. Lead acid batteries shall be tested under load and maintain a charge of 2.05 volts per cell
15. Strobes shall be tested to ensure they meet the minimum flash rate of 1 flash per second

Field serviceable system components

16. Most system components with today's fire alarm systems are replaceable
17. Technicians do not perform board level service on fire alarm system devices or components

Methods for cleaning system components

18. Smoke detectors which are found to be outside of their sensitivity range shall be cleaned or replaced
19. The cleaning shall comply with the manufacturer's written instructions
20. The lenses on photobeam det should be kept clean
21. The lenses for flame & smoke det shall be kept clean

Special Reference: 2.5 Fire Alarm System Wiring

Related References:	Wiring	pg 3
	Electricity	pg 6
	Installation	pg 9
	Electrical Installation	pg 19

Types of cable and conduit requirements

1. Nonpowered limited (NPLFA) cable is used for 110 volt fire alarm systems and devices
2. NPLFA shall be a minimum size of 18 AWG copper
3. NPLFA shall have a min insulation rating of 600 volts
4. Fire Power Limited (FPL) cable is the most common wiring used for fire alarm systems today
5. FPL shall have a minimum conductor size of 18 AWG for single conductors or 26 AWG for multi conductor
6. Cable types include in order of highest priority plenum, riser and general purpose
7. Class 1 circuits are installed and serviced by electricians Class 2 are low voltage fire alarm circuits

Correct and incorrect wiring methods

8. All FPL cabling shall be protected within 7' AFF
9. Fire circuits & junctions shall be clearly marked
10. Fire alarm circuits shall be provided with an overcurrent device rated at not more than 20 amps
11. Fire alarm devices shall be provided with double sets of terminals or appropriate locking terminals screws
12. Devices shall not be supported by their conductors
13. Fire alarm cable shall enter and exit junction boxes through approved fittings
14. Fire alarm wiring shall be attached to the permanent building structure, not sprinkler pipes or drop ceilings
15. Fire alarm devices shall be mounted in their proper orientation, not in any other way

Prepare a riser diagram

16. A riser diagram indicates fire alarm circuits and conductor counts with typical devices
17. Riser diagrams show fire alarm circuits extending from the control panel and EOL devices

Prepare plan view drawings

18. Plan view drawings are viewed as if looking down from the top
19. Fire alarm devices are appropriately spaced based on the scale of the drawing
20. Circuit wiring is indicated on plan drawings
21. Plan drawings become contract drawings which then become as built drawings

Special Reference: 2.6 Emergency Evacuation Signals

Related References: Alarm Notification Appliances pg 42
Voice Evac pg 46

Recommended fire alarm evacuation signal

1. The standard fire alarm evacuation signal is ANSI S3.41, which is Temporal 3
2. Temporal 3 is the internationally accepted evacuation signal but the term is not used in NFPA 72

Locations and uses of the fire alarm evacuation signal

3. The purpose of temporal 3 is to provide 1 recognized fire alarm evacuation signal which is always the same
4. When the purpose of the fire alarm system is evacuation at least 1 notification device per floor
5. Fire alarm strobes shall be clear or nominal white
6. Strobes shall flash a minimum of 1 per second and a maximum of 2 per second
7. When strobes are used audible devices may be reduced or eliminated with permission of the AHJ
8. Audible devices shall be located so they can be heard at the correct sound pressure level everywhere
9. Strobes are typically used in bathrooms, handicapped rooms and high noise areas

Code requirements for sound pressure levels

10. Public mode audibles shall not exceed 120 db
11. NFPA 72, requires a performance based option audibles shall sound at 15 db above average ambient sound or 5 db over max sound lasting 60 sec or more
12. Private mode audibles shall sound at 10 db above average or 5 db above max lasting 60 sec
13. Sleeping area audibles shall sound at a min of 75 db or 15db above average or 5db over max lasting 60 sec
14. The maximum sound pressure level for audibles shall 120 db, louder can be physically harmful to humans
15. When the average ambient sound level exceeds 105 db a strobe shall be required

Determine sound pressure levels

16. An approved sound pressure meter shall be used
17. Sound pressure shall be measured using the A weighted scale it closely follows human hearing range
18. Sound measurements shall be taken at 5 feet AFF
19. Sleeping area sound shall be measured at the pillow
20. All intervening doors or obstructions shall be in place
21. Average ambient sound determined over 24 hr period

Special Reference: 2.7 Combination Systems
Related References: None

Identify the combination systems which are permitted by NFPA 72

1. Combination fire alarm systems may include sprinkler system supervisory
2. Guard's tour supervisory may be combined with fire alarm systems guards used to perform fire watch
3. Combination burglar and fire systems are permitted
4. Fire alarm systems can share components with voice paging systems
5. Fire alarm systems can share components with music program systems
6. Coded paging systems and fire alarm systems can share components like speakers
7. Fire alarm systems and energy management systems
8. Fire alarm systems and process monitoring systems
9. Combination also applies to any common wiring for the fire alarm and other systems

Restrictions and requirements for combination systems

10. Underlying principle with combination systems any failure on the nonfire system shall not affect fire sys
11. Supervision of the fire alarm system shall not be affected by the non fire system
12. Fire signals shall not be affected by non fire system
13. Fire alarm signals shall take precedence
14. Fire alarm signals shall be distinctive
15. Any maintenance on the non fire system shall not affect the fire alarm system
16. Fire alarm speakers shall not be used for nonfire purposes unless the following are met
    -The fire command center is continuously occupied
    -Tampering safeguards are used & approved by AHJ
17. Interconnection of control units shall be permitted
18. Interconnection shall be supervised and achieved by listed relays, digital interface, or other listed methods
19. Local controls can be monitored as initiating devices
20. Commercial local controls shall be permitted to be connected to household fire alarm systems
21. The local control shall evacuate the household, the household system shall not evacuate the commercial bldg

General Reference: 3.1 Surveys for Fire Protection

Related References:	Devices & Components	pg 4
	Manual Pull Stations	pg 37
	Heat Detectors	pg 38
	Smoke Detectors	pg 39

Requirements for layout of automatic detectors

1. Smoke detector spacing permitted to be 30'
2. Smoke spacing unaffected by ceiling height (to 28')
3. Heat detectors shall follow devices listed spacing
4. Heat spacing shall be reduced based on ceiling height
5. Heat and Smoke detector spacing is affected by Joist and Beams. Generally Joists have a bigger affect
6. Joists & Beams project from the ceiling more than 4"
   a. Joists are spaced at 3' or less center on center
   b. Beams are spaced greater than 3' center on center
7. Joist & Beam rules for heat detectors
   a. Joists. reduce spacing by 50% perpendicular to joist
   b. Beams reduce spacing 33% perpendicular to beams
8. For smoke det spacing joists = beams (same affect)
9. Ceiling with beam depth less than 10% of ceiling height 30' spacing shall be used
10. When beam depth = or greater than 10% & beam spacing = or greater than 40% of ceiling height, smokes are located on ceiling in every beam pocket
11. Waffle or pan type ceilings with beams no greater than 24"& spacing no greater than 12', 30' spacing shall be used. Locate on ceiling or on bottom of beam
12. Projected beam det shall be parallel to the ceiling
13. Normally Projected beam spacing is 60'
14. Mirrors can reduce photo beam distance by 1/3rd

Use of detectors for various conditions

15. Smoke detectors should be installed in areas with:
   a. 32-100º F with humidity of 93% or less
   b. Air velocity of 300 ft/min or less
   c. Install only after construction cleanup is final
16. Ionization affected by altitudes over 3000'
17. Heat detectors are suitable for harsh environments.
18. Any fire alarm device used in a harsh environment shall be listed for use in that environment.

Determine quantity of detectors required

19. For open areas take the total square footage of the area and divide by area 1 detector will cover.
20. Consider a space which is 1800 ft^2. 1 smoke will cover 900 ft^2. 1800 ÷ 900 = 2 smokes

Determine best location for system components

20. Install components according to the manufacturer

General Reference 3.2: Shop & Riser Drawings

Related References:	Working Drawings	pg 7
	Contracts	pg 12
	System Layout	pg 18
	Specifications	pg 27
	Surveys for Fire Alarm	pg 46
	As Built Drawings	pg 53
	Contracts	pg 76

Review shop and riser drawings for compliance

1. Make sure proper fire alarm symbols are used
2. Riser diagrams are used to show wire runs, conductor counts, and summary of the system
3. As Built drawings show the actual way the system was installed including changes from shop drawings
4. Point to Point drawings show actual terminal connections at the control panel

Review Contract requirements for compliance

5. Review Division 16 requirements in the contract
6. Based on Division 16 requirements and the national codes determine the required fire alarm devices
7. Determine fire alarm requirements based on the building occupancy from NFPA 101
8. Determine installation requirements for devices from NFPA 72, The National Fire Alarm Code

Check for proper detector type and quantities

9. Based on the building occupancy, any of the following devices may be required:
   a.Pull stations (manual device)
   b.Smoke / heat detectors (automatic devices)
   c.Sprinkler system (waterflow and supervisory)
10. Usually if the bldg has a sprinkler system, then automatic detectors are not required
11. Usually if automatic detectors are used, then pull stations are not required throughout the bldg
12. At least 1 pull station is required for all bldgs which have waterflow or automatic detectors
13. Smoke detectors are required at all control equipment locations when not always occupied even when the bldg occupancy does not require smoke detectors.

Check for consistency and code requirements

14. Make sure mounting height and spacing requirements for devices are followed, NFPA 72 Chap 5 & 7
15. Audibility and illumination requirements for horns and strobes shall be met, NFPA 72 Chap 7
16. Contract requirements may exceed the requirements of the codes but not decrease the code requirements
17. Some contracts may require compliance with specific ADA requirements. These requirements are specifically detailed in the NTC Brown Book

General Reference 3.3 As Built Drawings

Related References:	Devices & Components	pg 4
	Manual Pull Stations	pg 37
	Heat Detectors	pg 38
	Smoke Detectors	pg 39

Requirements for inclusion in as built drawings

1. Contract drawings are prepared prior to the installation of the fire alarm system
2. As built drawings are the revised contract drawings based on the real world installation
3. As built drawings are also called Record Drawings
4. As built drawings specifically show the actual installation locations of fire alarm equipment
5. As built drawings shall include the following:
   a. Wiring raceway layout to include wire color and wire labeling
   b. Schematic diagrams of all control equipment
   c. Drawings which include all detector locations
   d. Specification sheets for all major system components
   e. Measured resistance values of all circuits
   f. Battery and voltage drop calculations

Change order and adjustments to as built drawings

6. Labels should be used to identify all devices and their zone information
7. The "Working" copy of as built drawings consist of a set of the original contract drawings. Any changes to the original design are annotated on the working copy.
8. Changes to device locations should be indicated on the working copy as the devices are installed
9. The as builts are intended to show precise dimensions and locations. These may not have been precise on the original contract drawings.
10. Once the installation is complete and all changes are indicated on the working copy, the as built drawings should be replaced with revised as built drawings

Distribution requirements for as built drawings

11. Appropriate distribution of as built drawings should include the following:
    a. Building owner: 3 sets of as built drawings
    b. General contractor: 1 set of as built drawings
    c. Fire alarm company: 1 set of as built drawings
    d. AHJ: Whatever the AHJ asks for
12. The as built drawings should always be available to the fire alarm service technician
13. As builts should be kept for the life of the system by all who are provided copies.

General References: 3.4 Principles of Smoke Movement in Bldgs
Related References None

Principles of smoke generation

1. There are 3 requirements for fire: Heat, Oxygen, Fuel
2. Hot Smoke Zones are areas where hot smoke rises to the ceiling. Energy and connections between rooms can cause hot zones to form in adjacent rooms
3. In hot smoke zones cooler less polluted air is forced toward the floor
4. Cool Smoke Zones are areas where buoyant lift in the smoke is not a factor. This lift is caused by heat.
5. In cool smoke zones other forces like wind, heat transfer, stack affect, HVAC systems control smoke movement in the building

Principles involved with the expansion of gas

6. Heat causes gases to expand and rise
7. Cooler gases tend to contract and descend
8. High pressure areas resist the expansion of gases
9. Low pressure areas permit the expansion of gases

Principles of smoke movement in tall buildings

10. The major factors which affect smoke movement in tall buildings are:
    a. Stack affect: explained in detail below
    b. Buoyancy: heated gas rises and expands. This can increase pressure levels in tall buildings
    c. Expansion: fires release energy which can cause smoke movement. This can increase pressure.
    d. Wind: wind can exert pressures which affect smoke movement. (see Brown Book pg 349)
    e. HVAC Systems: shut down during fire because the system supplies fresh oxygen to the fire and can transport smoke to other parts of the bldg

Principles involved with Stack Affect

11. Stack affect is caused by temp differences inside and outside of the bldg
12. Normal Stack affect: Temp inside the bldg is warmer, temp outside is cooler causes draft from floor to roof
13. Reverse Stack affect: Temp inside is cooler than outside: air moves from roof to floor of the bldg

Influence of partitions and ventilations systems

14. Partitions within 18" of ceiling can affect smoke

General Reference: 3.5 Supplementary Circuits
Related References Supervisory pg 21

Code Requirements for supplementary circuits

1. Relays shall be within 3' of controlled circuit/device
2. Control devices & gateways shall be listed as compatible with the control unit

Requirements for elevator shutdown and recall

3. Smoke detectors used for elevator recall shall be connected to the FACP & only detectors in the lobby, hoistway, & machine room shall be used for recall
4. Recall detectors shall maintain alarm capability when all other detectors are in alarm condition
5. Lobby smokes shall be within 21' of elevator center
6. Hoistway and machine room detectors may be programmed to initiate a supervisory signal
7. Designated Floor where elevator returns during alarm

10. Each group of elevators shall have 3 circuits:
    a. 1st used by the designated floor lobby detector(s)
    b. 2nd used by all other lobby detectors
    c. 3rd used by the hoistway/machine room detectors
11. When the machine room is located on the designated level it's detectors shall use the 1st control circuit
12. Heat detectors in hoistways shall be within 2' of head
13. Waterflow used for shutdown shall not have a retard
14. If power is lost to the shutdown control circuit the FACP shall indicate a supervisory signal
15. Heat detectors used for shutdown shall be rated lower than the sprinkler head
16. No smokes in hoistways unless there is a sprinkler there or its only job is activate smoke relief equip

Requirements for fan shutdown

16. Detectors used for fan shutdown shall be supervised

Code requirements for smoke management

17. Duct detectors shall initiate alarm or supervisory
18. Door release devices shall be supervised
19. All electronic door locks shall be connected to FACP
20. All exits shall unlock on alarm or power loss
21. Doors shall unlock prior to the evacuation signal
22. Failsafe door holders do not require secondary power

Code Restrictions and supervision requirements

22. Wiring to supplementary circuits shall be supervised
23. Failsafe relays shall be considered self monitoring

General Reference: 3.6 Signal Transmission

Related References:	Supervisory	pg 21
	Signal Transmission	pg 43
	Signal Processing	pg 45
	Addressable	pg 63
	Multiplexing	pg 64

Signal transmission within the system

1. Standard conventional signals are transmitted based on the circuit condition Opens/Shorts/ground faults
2. Multiplexing is the process of sending multiple signals at the same time over the same path
3. Multiplexing may be Active or Passive
4. Active multiplexing requires the control to POLL the devices connected to the system. The devices then respond to the control
5. There are 3 types of active multiplexing
   a. Ripple Through: the control sends 1 start signal. Each device responds in order and automatically based on the 1 start signal (old technology)
   b. Sequential Counting: the control sends a separate signal individually to each device. The devices respond when they receive their signal (old tech)
   c. Digitally Addressable: the control polls the devices. The devices respond with their address / location. This arrangement permits interrupt capability and random order communication (modern technology)
6. Passive multiplexing permits devices to send signals at any time without a control start signal
7. Analog data transmission permits 3 things:
   a. Identify the area of the alarm
   b. Identifies sensitivity setting of the device
   c. Provides verification times for each device
8. Analog transmission allows compensation for the long term changes in sensor response and adjusts for sensitivity shift due to time and environment

Power transfer with the system

9. When primary power fails, secondary power shall be available within 10 seconds
10. Transfer of power shall occur without loss of signals

Power and signal transmission over the same path

11. Some initiating devices which require power, like smoke detectors, may use a single pair of conductors to provide the path for power and signal transmission
12. Devices which use the same path for power, & signal transmission are required to be compatibility listed
13. This applies to all addressable smoke detectors and 2 wire conventional smoke detectors

General Reference: 3.7 Basic Electronics

Related References	Basic Wiring	pg 3
	Basic Electricity	pg 6

Understand the operating principles of circuits and electronic components

1. Ohm's Law states that Voltage = Current x Resistance
2. Voltage = E, Current = I, Resistance = R, Ohm's law is expressed as E = I x R
3. Series circuits provide a single path for current flow
4. The basic rules of operation for series circuits are:
   a. Voltage in series is additive
   b. Current in series is constant at all points
   c. Resistance in series is additive
2. Parallel circuits provide multiple paths for current flow in the circuit
3. The basic rules of operation for parallel circuits are:
   a. Voltage in parallel is constant
   b. Current in parallel is additive
   c. Resistance in parallel is equal to or less than the value of the smallest resistor
4. Electrons flow from negative to positive

Be familiar with inductance and capacitance

5. Inductance is caused by being close to a magnetic field or electric charge or an electric current
10. Inductance is used in transformers
11. Inductance is expressed in Henrys
12. Capacitance is the ability to store a charge
13. Capacitance is expressed in Farads
14. Capacitors are used on circuit boards

Be familiar with relays, LEDs and transfer switches

15. Relays are electrically isolated switches
16. Relays function as an On / Off switch
17. Relays are commonly used in fire alarm systems for elevator control, fan/damper shutdown & door control
18. LEDs are used for annunciators and status indicators
19. Transfer switches are used to switch to an alternate power source

Be Familiar with Diodes, Oscillators, and Amplifiers

20. Diodes permit voltage to pass in one direction only
21. Diodes are only effective for DC Circuits
22. Oscillators are used to measure AC current, frequency and voltage
23. Amplifiers are used in fire alarm notification speakers

General Reference: 3.8 Notification Appliances

Related References	Alarm Notification	pg 42
	Voice Evac	pg 44
	Evacuation Signaling	pg 49

Application of audible/visible & combination devices

1. Audible devices shall be mounted 90" AFF to the top
2. Ceiling mounted audible devices are permitted
3. For combination audible/visible devices, the visible mounting requirements take precedence
4. Wall mounted visible appliances shall be mounted so that the entire lens is 80" AFF or greater, up to 96"
5. When more than 2 visible appliances are in any field of view, they shall be synchronized
6. Strobe spacing is based on rooms which are square & this ensures proper illumination throughout the area
7. For rooms which are not square, use a square which will encompass the entire room size
8. Strobes which are ceiling mounted shall be located at or below 30'
9. Strobes shall be located within 15' of corridors
10. Strobe spacing in corridors shall not exceed 100 feet

Principles of alarm by zone and signal coordination

11. All devices in each notification zone shall be synched
12. Alarm by zone is typically done with voice evac
13. Multichannel is the capability to broadcast the evacuation signal in some zones and voice instructions in other zones

Use of visual & tactile appliances for the handicapped

14. ADA requires strobes to have a minimum of 75 cd and be wall mounted
15. ADA permits equivalent facilitation for visual devices
16. Tactile devices are detected by touch for the hearing impaired, like vibrators
17. In sleeping areas strobes located 24" or farther from the ceiling to the top of the lens shall be 110 cd
18. In sleeping areas strobes located closer than 24" of the ceiling to the top of the lens shall be 177 cd

Attenuation affects of distance and partitions

19. 3db Rule: Double wattage, 3 db increase
20. 6db Rule: Double distance, 6 db loss

Compensation for ambient sound levels

21. Audibles shall sound 15 db above ambient (5db above max sound level which lasts 60 seconds or more)
22. Ambient sound level greater than 105 require strobes

General Reference: 3.9 Basic Principles of Combustion

Related References None

Fire signatures as they relate to fire detection

Stage of Fire	Fire Signature	Detector
Incipient	Ionized particles	Ionization
Smoldering	Larger particles	Photoelect
Flame	Radiation energy	Flame det
Heat	High temperature	Heat det

1. Aerosol (Smoke) signatures are the gases & particles formed as a result of fire. Essential feature of smoke is its instability
2. Visible: 0.3 mirometers or bigger. Scatters light
3 Invisible: Less than 0.3 microns. Do not scatter light
4. Thermal particulate point: Temperature where sub micron particles are generated.

PVC Insulation	290ºF	Bakelite	380ºF
Motor Oil	310ºF	Polyethelene	410ºF
Pine Board	320ºF	Paper	500ºF
Acrylan Carpet	340ºF	Polystyrene	710ºF
Wool	360ºF		

5. Infrared flame detectors false alarm when they look for just 1 particle size. Using 2 different particle sizes are more stable. IR detectors look for:
   a. Carbon dioxide: 4.4 micrometer particles
   b. Water vapor: 2.7 mirometer particles
   c. Flame flicker range of 5-30 Hz
6. Ultra violet fire signatures are characterized by:
   a. Hydroxal emissions, Carbon dioxide and Carbon monoxide ranging from 0.27 – 0.29 micrometers
7. Detectable levels of carbon monoxide = 75- 100 ppm
8. Effects of the products of a fire
   a. Aerosols: Can cause decrease in visibility & panic may result. May make breathing difficult.
   b. Heat: Results in burns, damage to lungs & shock
   c. Toxic Gases: CO & CO2 produced at toxic levels
   d. CO: 50% of fire fatalities are from CO poisoning
   e. CO2: Increases breathing & other complications
   f. HCL: Associated w/ plastics. Can be fatal
   g. Oxygen Depletion: Usually confined to area of fire
   17-21% Oxygen Loss of coordination & thinking
   14-17% Oxygen Rapid pulse & dizziness
   11-14% Oxygen Nausea, vomiting & paralysis
   9% Oxygen for 5 min Unconsciousness
   6% Oxygen for 2 min Death in a few minutes
9. Transport of fire signatures: Indications of fire must reach the detector to be detected.

General Reference: 3.10 Styles of Circuits
Related References Supervision pg 21

Differences between class A & B circuit styles

1. Class A Initiation Styles: D, E
2. Class A Notification Styles: Z
3. Class A Signaling: 2, 5, 6, 7
4. Class B Initiating Styles: A, B, C
5. Class B Notification Styles: W, X, Y
6. Class B Signaling: 0.5, 1, 3, 3.5, 4, 4.5

Characteristics of initiating device circuit styles

7. Single Open: The performance of the circuit is:

Style D, E	Trouble w/ alarm capability
Style A, B, C	Trouble

8. Single Ground: Circuit style characteristics

Style D, E, B, C	Trouble w/ alarm capability
Style A	Trouble

9. Wire to wire short: Circuit style characteristics

Style D, A, B	Alarm
Style E, C	Trouble

10. Loss of Carrier: Circuit style characteristics

Style D, A, B	No signal
Style E, C	Trouble

Characteristics of notification appliance circuit styles

11. Single Open: Circuit style characteristics

Style Z, X	Trouble w/ alarm capability
Style W, Y	Trouble

12. Single Ground: Circuit style characteristics

Style Z, Y	Trouble w/ alarm capability
Style W, X	Trouble

13. Wire to wire Short: Circuit style characteristics

Style: W, X, Y, Z Trouble

Characteristics of signaling line circuit styles

14. Signaling line circuit styles are characterized by multiplexing. Addressable devices use these circuits

Performance of circuit styles during abnormal conditions

15. The performance of various styles of circuits are detailed in NFPA 72 and Chuck Notes.
16. Class A circuits perform to a higher standard than Class B circuits

General Reference: 3.11 System & Component Compatibility
Related References None

Requirements for system & component compatibility

1. All equipment shall be listed for use
2. System and component compatibility specifically means the control panel and all devices which receive power and send signals on 2 wires must be listed for use with each other.
3. Fire alarm devices which fall into this requirement are 2 wire smoke detectors and all addressable devices.
4. Voltage is the other compatibility requirement. Devices must have the same voltage input requirements as the control panel's voltage output.

Requirements for 2 wire smoke detector compatibility

5. Compatibility Listed: A specific listing process that applies only to 2 wire devices such as smoke detectors that are designed to operate with certain control panels.
6. Compatibility lists are available from the manufacturer.
7. Normally, the 2 wire device and the control panel have to be manufactured by the same company.

Requirements for 2 wire smoke & relay compatibility

8. Compatibility Listed requirements also apply to addressable 2 wire relays which are used by addressable fire alarm control panels.
9. Compatibility lists for addressable relay modules are available from the manufacturer.

Requirements for control equipment compatibility

10. Conventional 2 wire smoke compatibility is based on the current / voltage input requirements of the device and the current / voltage output of the control panel.
11. Conventional 2 wire smoke compatibility normally lists the number of devices permitted on the 2 wire smoke circuit from the control panel.
12. Addressable 2 wire device compatibility is based on the communication (multiplexing) protocol of the device and the control panel.

Check for testing lab compatibility

13. Lists provided by equipment manufacturers

General Reference: 3.12 Transient Protection
Related References None

Possible effects of RFI/EMI interference

1. There are 2 types of transients
   a. Low Energy: Most common type and generally has high voltage with a short duration and low energy content.
   b. High Energy: Although rare, are usually caused by direct lightning strikes and usually cause catastrophic equipment failure. Requires elaborate protective measures.
2. Possible effects of RFI/EMI
   a. Nuisance alarms
   b. Partial damage to some equipment, intermittent
   c. Equipment failure
   d. Wiring problems

Potential sources of RFI/EMI interference

3. Lighting strikes direct or induced
4. Uneven power line conditions and transients
5. Transients generated by switching various system components, such as relays, bells etc.
6. Interference induced by capacitive, inductive or electromagnetic coupling to system wiring from nearby motors, neon signs, radio frequency transmitters etc.
7. Direct coupled transients on system wiring (other than those on power lines) that are caused by direct or secondary lightning strikes and other events (usually catastrophic to equipment)

Techniques to minimize effects thru design & install

8. Testing labs put fire alarm equipment through extensive transient testing.
9. There still may be excessive electrical transients in the building that houses the fire alarm equipment and installation.
10. Installation of transient protection in the field should be considered.
11. To be effective transient suppressors must conduct more current than the corresponding increase in voltage rise indicates. Typical devices which work:
    a. Thyristors
    b. Metal Oxide Varistors (MOV)
    c. Zenar Diodes
    d. Spark gaps

General Reference: 3.13 Addressable Systems

Related Reference Multiplexing pg 64

Concept and benefit of addressable systems

1. Addressable systems use a 2 wire data loop called a signaling line circuit (SLC).
2. Addressable initiating devices have circuitry which transmit signals over the data loop
3. Analog data transmission. Analog detectors have the ability to do 3 things
   a. Identify area of alarm
   b. Identifies sensitivity setting of device
   c. Provides verification times for each device in system
4. Analog data transmission allows compensation for long term changes in sensor response: Analog adjusts for sensitivity shift due to time & environment.

Supervision requirements & procedures for addressable

5. All installation conductors shall be monitored for integrity (including addressable systems)
6. T tapping shall be permitted where systems are listed for such wiring and supervision is maintained.

Signal transmission ie ripple thru, sequential digital

7. Addressable system signal transmission is characterized by multiplexing.
8. Multiplexing is the protocol for sending multiple signals over 1 transmission path.
9. Addressable circuits are 2 wire circuits with many devices connected to the circuit. It is common for 1 addressable circuit to accommodate 100+ devices.
10. With 100 or more devices on 1 circuit a protocol has to be established so no information is lost.
11. The types of multiplexing are Ripple Through, Sequential Counting and Digitally Addrressable
12. Ripple Through. Control panel send 1 start signal and each device transmits its status in turn.
13. Sequential Counting. Control panel sends separate signal for each device to transmit its status.
14. Digitally Addressable. Each device has digital address. Control panel polls devices just as in other 2 types, but device responds with address/location. This allows for interrupt capability and random order communication. Requires higher speed transmission.

General Reference: 3.14 Multiplexing

Related References Addressable pg 63

How multiplexing works

1. Multiplexing. A protocol for sending multiple signals over the same path. Can be active or passive.

Principles of active multiplexing

2. Active multiplexing. The control polls devices and devices then communicate with the control
3. There are 3 types of active multiplexing:
   a. Ripple through: Control panel send 1 start signal & each device transmits it's status in turn.
   b. Sequential counting: Control panel sends separate signal for each device to transmit its status.
   c. Digitally addressable: Each device has digital address. Control panel polls devices just as in other 2 types, but device responds with address/ location this allow for interrupt capability&random order communication. Requires higher speed trans.

Principles of passive multiplexing

4. Passive multiplexing. Control does not poll devices but allows devices to send in status at any time.

Multiplexing systems and components

7. Fire alarm systems with multiplexing capability use microprocessor units and each device has a transmitting devices for sending information to the control panel of the system.

Wiring methods for multiplexed circuits

8. Multiplexed circuits generally use 2 conductors.
9. T tapping is normally allowed based on system listing
10. Class A SLC cannot be T tapped
11. Coded fire alarm systems are passive multiplexed.
12. Wireless (RF) are passive multiplex devices.

Functions of microprocessors

13. Microprocessors provide system diagnostics.
14. Microprocessor based fire alarm systems use thousands of transistors to obtain functionality
14. They allow incorporation of integrated systems.
15. They provide the circuitry necessary for analysis of smoke detector sensitivity.
16. Automatic operation of system controls points & provides system information to the user.

General Reference: 3.15 Interconnection with Extinguishing Systems
Related References None

Fire alarm actuation of extinguishing systems

1. Fire alarm systems may be required to actuate an extinguishing system.
2. There is a special listing for fire alarm panels which are utilized for suppression.
3. There are several types of extinguishing systems.
4. Halon 1301. Quickly extinguishes all classes of fire & causes no residual damage. Causes ozone depletion.
5. Carbon Dioxide. Stored as liquid under pressure. It reduces oxygen to the point where combustion fails.
6. FM-200. Replacement for halon, non ozone depleting
7. Inergen. Mixture of 3 gases (nitrogen 52%, argon 40%, Carbon Dioxide 8%) oxygen reduction.
8. FE-13. A gaseous chemical refrigerant, safe to use in occupied areas, uncreative, and ozone safe.
9. Wet Chemical. Applied in concentrated liquid spray. Reacts with grease / oil to produce synthetic foam
10. Dry chemical. Sodium bicarbonate based for Class B and Class C fires. Monammonium phosphate based for Class A fires.
11. Low expansion foam. Bubble expansion is less than 20 to 1 and has a high water content. Used for special hazards involving flammable liquids.
12. Medium - high expansion foam. Bubble expansion is between 20 to 1 thru 1,000 to 1 low water content.
13. Aqueous film forming foam. (AFFF) works like low expansion foam, but is capable of producing water solution films.

Interconnection of various extinguishing systems

14. Audible alarms shall indicate system discharge;
15. Notification shall provide warning of discharge

Types of detectors used for various extinguishing sys

16. When used for extinguishing system operation,
17. Detectors should alternate between ionization and
18. Photoelectric & be cross zoned.
19. Preaction system. Automatic detection causes sprinkler pipe to flood with water which is allowed to flow from any open sprinkler head.

Uses of cross zoning with extinguishing systems

20. Cross zoning increases reliability. Using 2 detectors to actuate reduces risk of false discharge.

Special Reference: 3.1 Off Premise Signal Transmission

Related References	Signal Transmission	pg 43
	Signal Processing	pg 45

Characteristics of signaling transmission technologies

1. Wire transmission uses copper conductors.
2. Fiber optic transmission uses light through glass.
3. Wireless transmission uses RF.

Transmission of signals through wire, fiber, wireless

4. Transmission of signals through all technologies may be conventional. This means a single piece of information is conveyed (Open or Closed circuit).
5. Transmission of signals through all technologies may be addressable. This means that more than just a single piece of information is conveyed.

Advantages of each type of transmission means

6. Copper is very common and relatively inexpensive. It is a familiar technology and can be mastered quickly.
7. Wireless is the easiest technology to install. There is no requirement for installing wire to every device.
8. Fiber optic cable provides the best security and is immune to interference. Fiber is highly reliable and has the most bandwidth.

Limitations of each type of transmission means

9. Copper requires more installation work and has limited bandwidth capabilities.
10. Wireless is expensive and has a limited range. It may not work in all applications.
11. Fiber optic cabling is expensive and requires special training and knowledge to work with.

Code requirements for each type of transmission

12. Loading capacities for off premise signal transmission are specified by system Type.
    a. Type 1 System. Most reliable active multiplex.
    b. Type 2 System. Active multiplex w/o dual control.
    c. Type 3 System. Active multiplex, basic.
    d. Type 4 System. 2 way RF with high reliability
    e. Type 5 System. 2 way RF basic
    f. Type 6 System. 1 way RF with high reliability
    g. Type 7 System. 1 way RF basic.
13. Standard phone line systems have the largest loading capacities and are not identified by system type. They are simply called digital alarm communication systems (DACS).

Special Reference: 3.2 Low Power Radio (Wireless)
Related References None

Requirements for low power radio systems

1. By code, low power radio, wireless, fire alarm equipment is permitted for commercial use.
2. Wireless commercial fire alarm equipment shall be properly listed.

When / where low power radio systems are permitted

3. Most AHJ's are reluctant to approve wireless fire alarm systems except for special applications:
   a. Historical buildings
   b. Some existing government buildings
   c. Temporary structures
4. Most jurisdictions will not accept wireless fire alarm equipment for normal applications.

Supervision, power supply and transmission requirements

5. Wireless transmitters shall be supervised.
6. Transmitters shall be listed as highly resistant to interference and highly reliable.
7. A single transmission fault shall be indicated within 200 seconds and shall not generate an alarm.
8. Removal of a transmitter shall immediately send a supervisory signal which is specific to the transmitter.
9. Interfering signals which persist for more than 20 seconds shall indicate a visible and audible trouble signal and identify the source as an interfering signal.
10. Dry cell batteries can be used as primary power when:
    a. Transmitters serve 1 device and 1zone.
    b. The battery shall last 1 year.
    c. Low batt signal required 7 days prior to failure.
    d. Low batt signal identifies the affected transmitter.
    e. Low batt signal shall be distinctive.
    f. When silenced, low batt resounds every 4 hours.
    g. Catastrophic low batt identifies the transmitter.
    h. Battery fail in 1 transmitter does not affect others.
11. Each actuated transmitter automatically sends alarm.
12. Max delay from actuation to notification 10 seconds.

Special signaling requirements for low power radio

13. Use of wireless to activate notification appliances shall be able to meet power supply requirements and the wireless channel shall be supervised.

General Reference: 4.2 Features for Hostile Environments
Related References None

Design features required for severe environments

1. Equipment used in sever environments shall be listed for use in those environments.
2. Control equipment shall be located in areas where:
   a. The temperature is between 32º-120º Fahrenheit
   b. 85%-110% of nameplate voltage is available
   c. Humidity does not exceed 85%
3. Smoke detectors require a specific environment:
   a. Temperatures which do not exceed 32º-100º F
   b. Relative humidity at 93% or less
   c. Air velocity at or below 300 ft/min
4. An engineering evaluation may be required to determine the best protection for severe environments

Requirements for unheated structures

5. Unheated structures are not suitable for installation of automatic smoke detectors.
6. Heat detectors are a good choice for this application.
7. Flame detectors may be a good choice. They must have an appropriate listing and usually an engineering evaluation is required for installation.
8. Pull stations located in unheated structures shall be listed for the environment.
9. Notification devices shall be listed for the environment in which they are installed.

Requirements for structures subject to vandalism

10. Fire alarm devices in structures subject to vandalism should have protective covers.
11. Protective covers shall be listed for use.
12. Protective covers for detectors shall be listed for use with the detector.
13. Notification appliance covers shall be listed for use with device.

Requirements for high humidity or corrosive areas

14. Equipment, raceways and wiring shall be protected against corrosion.
15. Approved corrosion resistant materials include zinc, cadmium and enamel.
16. Enamel shall not be used outdoors or in wet areas.
17. Concrete or direct earth contact installations require appropriate corrosion protection.
18. In wet areas, equip shall be spaced ¼" from the wall.

General Reference: 4.3 System Reliability
Related References None

Installation methods to increase reliability

1. There are several methods increase system reliability
2. Follow the code. Fire alarm systems which are designed and installed according to the code are more reliable than systems in violation of code.
3. Central Station Systems. Meeting the installation requirements and service elements of this type of system ensures higher reliability.
4. Class A Circuits. Fire alarm systems are not required by any code to use class A circuits. Class A circuits provide a higher degree of reliability

Locate equipment in a suitable environment

5. Control equipment shall be located in areas where:
   a. The temperature is between 32º-120º Fahrenheit
   b. 85%-110% of nameplate voltage is available
   c. Humidity does not exceed 85%
6. Heat detectors may be used in uncontrolled environments.
7. Smoke detectors shall only be installed in suitable controlled environments.

Physical protection options for wiring & equipment

8. Conductors shall be protected within 7' AFF.
9. Wiring shall be supported by the bldg structure.
10. Wiring shall be fastened every 18".
11. Installation of wiring in conduit is acceptable.
12. Equipment protective covers shall be listed for use.
13. Protective covers for detection devices shall be listed for use with the detector.

Layout a voice evacuation system to ensure that attack by fire on one paging zone does not disable the system

14. Voice evacuation systems require that conductors for each paging zone be individually installed
15. Failure of one paging zone shall not affect other zones
16. All conductors shall be supervised..
17. Central control equipment shall be located in a 1 hour rated fire resistive area with at least 3' of clearance.
18. Speakers are required to meet audibility requirements for public mode notification

General Reference: 4.4 Fire Hazard Analysis
Related References None

Analyze the threat for a facility and select the best equipment for the application

1. Analysis of the threat has to be based on the fire protection goals of the facility. Those goals may be:
   a. Life Safety. Provides a complete smoke detection system throughout the facility
   b. Property Protection. Normally provides heat detection
   c. Mission Protection. This provides protection such that the company operations can continue even after a fire incident.
2. Smoke detectors provide life safety. A smoke will actuate prior to the affects of the fire reaching a lethal point for humans.
3. Heat detectors do no provide life safety. Heats are slow to respond. They actuate after the affects of the fire reach lethal levels for humans.
4. Selecting the best detector depends on the fire protection goals and the stage of fire.

Stage of Fire	Fire Signature	Detector
Incipient	Ionized particles	Ionization
Smoldering	Larger particles	Photoelect
Flame	Radiation energy	Flame det
Heat	High temperature	Heat det

5.Fire growth rate is the speed with which a fire will grow. Materials burn at different rates.

6.Power law growth formula identifies predictable growth of flaming fires with a stable fuel source.

7.1055KW/sec is used as the point to determine fire growth speed.

Growth Rate	Growth Time (to reach 1055KW/sec)
Ultrafast	Less than 75 seconds
Fast	75 sec up to & including149 sec
Medium	150 sec up to & including 399 sec
Slow	400 seconds and up

8. The process for fire hazard analysis includes:
   a. Selecting target outcomes
   b. Determining the scenarios of concern
   c. Selecting methods of prediction
   d. Evacuation calculation
   e. Analyzing the impact of exposure
   f. Examining the uncertainty

General Reference: 4.5 Avoidance of Nuisance Alarms
Related References None

Proper location & maintenance of fire detectors

1. Smoke detectors require a specific environment:
   a. Temperatures which do not exceed 32º-100º F
   b. Relative humidity at 93% or less
   c. Air velocity at or below 300 ft/min
2. Smokes be sensitivity tested within the 1st year.
3. All smokes shall be checked every alternate year.
4. If a smoke remains within its sensitivity range for both 1st & 2nd test, testing can be extended to 5 years.

Features to reduce false alarms

5. The best way to reduce false alarms is use quality listed equipment, follow installation instructions and follow the code requirements.

Alarm Verification

6. Alarm verification ignores the first signal. If a second signal is indicated by the same device within 60 seconds, the alarm signal is processed as real.
7. If a second device indicates an alarm signal, it is considered real and he signal is processed.
8. Alarm verification should not be used as a substitute for proper system design and installation.

Positive alarm sequence

9. Provides an opportunity to investigate the signal.
10. The signal is sent to a constantly attended location where is must be acknowledged in 15 seconds.
11. The attendant has 3 minute to investigate the signal & if false, reset the alarm.
12. Failure by the attendant results in auto notification.

Cross zoning

13. Requires 2 separate detectors in the same space to actuate in order to initiate an alarm signal.

Electronic retard mechanisms

14. Used on waterflows. Delays alarm for 90 seconds in order to ensure sustained water flow (actual alarm).

Presignal systems

15. Requires fire alarm system monitoring. Similar to positive alarm sequence. Requires human action for notification

General Reference: 4.6 Special Protection

Related References	System Layout	pg 18
	Smoke Detectors	pg 39

Layout a detection system for a computer room

1. Ionization detectors are normally used.
2. Air sampling network systems are commonly used because they provide the earliest notification
3. Detectors required under raised floors & above drop ceilings. Data wiring interference may be a problem.
4. Computer rooms frequently have plenum areas.

Properly locate smoke detectors

5. Smoke detectors located under raised floors shall be in their proper orientation.
6. Smoke detectors should be mounted to boxes.
7. In open areas, smoke spacing is permitted to be 30'
8. In corridors, use extended spacing as permitted by the 0.7 rule
9. Smoke detector should only be in areas 32º-100º F, 93% humidity or less, air velocity 300 ft/min or less.

Requirements for extinguishing system interconnection

10. Sprinkler systems. Waterflow = alarm signal, control valve = supervisory signal.
11. Clean agent / CO_2 Discharge = alarm signal, also discharge may close dampers, doors, fans. Occupant notification of discharge may be required.
12. High expansion foam. Discharge = alarm signal
13. Water mist system. Discharge = alarm signal

Requirements for cross zoning & sequential shutdown

14. Cross zoning requires 2 detector actuation to generate an alarm signal It can be used under these conditions:
    a. When it is not prohibited by the AHJ
    b. At least 2 detectors are in each space
    c. Alarm verification cannot be used
15. Sequential shutdown. This is a process which initiates a sequence of events prior to shutdown / discharge of an extinguishing agent.

Place detectors in high rack storage

16. Install detectors on the ceiling above each aisle and at intermediate levels in the racks.

General Reference: 4.7 Requirements for Listing
Related References None

Testing lab requirements for listing

1. Testing labs conduct performance tests on fire alarm equipment to ensure reliability.
2. Heat detectors have a listed spacing. Smoke detectors do not have a listed spacing.
3. Heat detector testing uses an alcohol pan fire. Heat detectors are installed at maximum spacing on a ceiling with sprinklers rated at 160º (spaced at 10')
4. The heat detector must operate within 2 minutes and must operate before any of the sprinkler heads.
5. Smoke detector testing uses 5 different fire types.
   a. N-heptane. Flaming f ire with black smoke
   b. Polystyrene. Flaming fire with black smoke
   c. Wood. Flaming fire with gray smoke
   d. Newspaper. Flaming fire with gray smoke
   e. Wood on a hotplate. Smoldering fire gray smoke
6. Smoke testing uses a smoke box with the detector oriented in its least favorable position and set at minimum production sensitivity.
7. All smoke detectors must detect all 5 types of fires.
8. Smoke detectors may also be tested using a Measuring Ion Chamber (preferred for ionization)

Requirements for general construction, components, performance and manufacturing follow up

9. Quality assurance. Based on an independent inspection by 3rd parties such as product approval, periodic inspection by regulatory officials & licensing
10. Quality systems. Based on documentation and standardized procedures such as ISO 9000.
11. NECA 305. Standard for fire alarm system installation and maintenance.
12. NICET Certification. Certification program for fire alarm system technicians and designers
13. ISO Technical Committee 21. Develops test standards for fire detectors and components.
14. Testing labs. Manufacturers submit products for testing. The lab subjects equipment the tests and standards developed by the lab. Once passed, an engineer develops inspection procedures.
15. Inspections. The testing lab conducts unannounced inspections at the manufacturing facility. Inspectors check production units and audit quality assurance.

Special Reference: 4.1 Public Fire Alarm Reporting Systems

Related References Auxiliary Fire Alarm pg 33

Requirements for communication centers and fire departments

1. Public fire alarm systems are city owned & include the wiring, street boxes & communication equipment.
2. Communications center is responsible for receiving alarm signals, maintaining equip and dispatch.
3. The comm center shall be in a fire resistive or protected noncombustible / limited combustible area.
4. Separation by a 2 hour fire rated wall is required.
5. Entry to the communications center should be protected by 2 doors and a vestibule (man trap).
6. The HVAC system is required to be independent.
7. The comm. center requires 2 power sources.

Type of dispatching systems

8. Type A dispatching required where more than 2500 alarm signals are processed each year.
9. Type A requires approved automatic retransmission with an operator override for manual retransmission.
10. Type B dispatching used when 2500 or less alarm signals are processed each year.
11. Type B retransmission may be automatic or manual.
12. Computer Aided Dispatch (CAD). CAD is used to dispatch the appropriate responding units, maintain information on status and coordinate activities.

Fundamental requirements for public systems

13. One street box can cover 100,000 square feet.
14. A fire alarm annunciator is required near the street box when a fire system is connected to the box.
15. Street boxes require distinctive color and a light visible for 1500 feet in all directions
16. Street box power shall be AC, battery or solar & require a sealed lead acid battery back up capable of 60 hours operation.

Types of systems used for fire alarm reporting

17. A Master Fire Alarm Box is capable of both manual & electronic actuation. Can connect to a fire panel.
18. A Manual Fire Alarm Box is only capable of manual actuation. Fire alarm panels cannot be connected.
19. A Master Transmitter is only capable of electronic actuation. Specifically intended to connect to a panel.

Special Reference: 4.2 Project Scheduling & Coordination

Related References None

Read construction schedules

1. The construction schedule is maintained by the general contractor / project manager
2. The scheduling requirements for the fire alarm system are require coordination with the other trades

Separate fire alarm system requirements

3. Fire alarm system requirements are found in Division 16 Electrical of the specification documents.
4. The requirements for duct detectors are in Division 15 Mechanical of the specification documents.

Provide scheduling input for CPM, PERT, or bar schedules

5. CPM = Critical Path Method. This is a scheduling technique which identifies the construction sequence of events, the expected timeline, and the critical events for on time completion.
6. PERT is an enhancement of the CPM which includes maximizing efficiency and making required alterations at the earliest opportunity.
7. Gantt Chart. This is a horizontal bar chart used to provide an illustration of progress for scheduled tasks.
8. Bar Schedule. This is an easy to understand, graphed representation of scheduled work progress and timeline for the contracted work. The bar schedule is very common in the construction industry.

Communicate with other trades

9. Formal communication with other trades is typically done through the general contractor with additions or change orders to the contract.

Maintain a drawing file with change orders

10. The contract drawings should be maintained in an appropriate file. Normally this is a function of the general contractor.
11. The contract drawings are also referred to as the working drawings. Changes based on the actual installation are annotated on the working drawings
12. As built drawings are completed once the work is completed. As builts show actual device locations and wire run locations.

Special Reference: 4.3 Contractual Requirements

Related References	Contracts	pg 28
	Bid Invitation	pg 77

Determine requirements of contracts and clauses

1. Contract documents include everything including graphics prepared by architect / engineer
2. The layout of contract documents is covered by 33011

Element of liability performance and pay bonds, hold harmless agreements

3. Performance bonds. Provides protection for the owner
4. Payment bonds. Provides protection for the labor force and suppliers.

1. Certificates. Include insurance documents & certificate of compliance w codes & local requirements.

Requirements of federal & state regulations

2. Copeland Antikickback Act. Precludes contractors / subcontractors from inducing employees to accept less than federal wage for federally funded projects.
3. Davis Bacon Act. Prevailing wage act. Applies to federally funded construction over $2,000.00

9.Executive Order 11246(11375). Prohibits employment discrimination by contractors who do over $10,000 of federally funded work per year.

Obligations of contract administration

10.The general contractor is responsible for contract administration.

Preparation of requisitions

11.Properly completed requisitions may be required for federally funded contracts when changes occur.

Revenue factors like retention and progress payments

12. The contract may specify revenue and payment issues. It is common for a percentage to be paid up front, then a payment when the installation wiring is completed & final payment after system acceptance.

Punch list and job completion considerations

13. Punch list. Unresolved items from the contract.
14. Lien release & wavier of claim affidavit is normally provided prior to final payment
15. Liquidated damages is a penalty for not completing the job on time.

Special Reference: 4.4 Bid Invitation Package

Related References	Plans & Specifications	pg 12
	Specifications	pg 27
	Contracts	pg 28
	Bldg Codes	pg 29

Be familiar with common bid requirements

1. Invitation to bid may have many different aspects depending on the project and area of the country.
2. A bid invitation usually includes requirements for a responsive bid & provides info on the project itself.
3. Prequalification of contractors may be required
4. Supplemental provisions may include additional items not suited in the special conditions

Specification Requirements

5. There are 3 parts of a specification
   a. General clauses and agreements
   b. Technical instructions
   c. Acceptance of the systems
6. The parts of a contract document are as follows:
   Division 1: General
   Division 2: Site work
   Division 3: Concrete
   Division 4: Masonry
   Division 5: Metals
   Division 6: Wood and Plastics
   Division 7: Thermal Moisture
   Division 8: Doors and Windows
   Division 9: Finishes
   Division 10: Specialties
   Division 11: Equipment
   Division 12: Furnishings
   Division 13: Special Construction
   Division 14: Conveying Systems
   Division 15: Mechanical
   Division 16: Electrical (including fire alarm)
7. Federal bid packages include:
   a. Bid invitation form
   b. Instructions to bidders
   c. Labor standards provisions, Davis Bacon Act
   d. Representation & Certification, Affirmative Action
   e. Bonds
   f. Working hours
   g. Codes
   h. Taxes
   i. Buy American Requirements
   j. Guarantees

Special Reference: 4.5 Smoke Control Systems

Related References Smoke Movement in Bldgs pg 54

Purpose and operation of smoke control systems

1.The purpose of a smoke control system is to prevent the harmful affects of fire/smoke to unaffected parts of the building.

Methods of controlling smoke spread

2.Ventilation recirculation. Prevent the smoke from being recirculated by the HVAC system

3.Exhaust. Selective operation of specialized equipment to exhaust the smoke from the building

4.Pressurization. Selective operation of equipment to pressurize smoke compartments and contain the spread of smoke.

5.Door release. Close doors which are normally open in order to prevent the spread of fire/smoke.

Basic requirements for smoke control systems

6.Fire safety wiring shall be supervised to within 3' of the controlled device or circuit.

7.Smoke control devices shall be listed for use.

Type & location of detectors used for smoke control

8.Open area smoke detectors. Open area detectors can be used to operate smoke control systems. Open area detectors can operate door release and unlocking, dampers, fans & environmental controls.

9.Air duct detectors are required on HVAC units with supply greater than 2000 cfm and return greater than 15000 cfm serving 2 or more floors.

10.Door release detectors can close fire doors

Requirements for air duct smoke detectors

11.Duct detectors are not a substitute for open area det

12.Remote indicator required if duct det greater than 10'

13.Duct detectors should be 6-10 duct widths away from bends and return air inlets whenever possible.

Requirements for door release smoke detectors

14.Location of door release smoke detectors is based on the distance from the top of door to the ceiling:

a. Less than or equal to 24" on both sides = 1 detector.

b. Greater than 24" on both sides = 2 detectors.

c. When 1 side is equal to or less than 24" and the other is greater than 24" = 1 detector on the high side

Special Reference: 4.6 Heat Detectors

Related References Heat Detectors pg 38

Operation of various types of heat detectors

1. Heat detectors respond much more slowly than smoke detectors. They are not a life safety device.
2. Fixed temp heat detectors operate when the collector element reaches a specific temp. Normally air temp is much higher due to thermal lag.
3. Fusible element heat detectors (like sprinkler heads) operate when the fusible link melts. Nonrestorable
4. Bimetallic heat detectors use 2 metals with different rates of thermal expansion. Increased temp causes expansion and bending which closes the contacts.
5. Line type heat detectors are 2 conductors separated by heat sensitive insulation. The insulation melts with heat and the 2 conductors short generating a signal.
6. Rate compensation heat detectors are used to compensate for thermal lag
7. Rate of rise heat detectors operate when the temperature rises more than 15º per minute.
8. Sealed pneumatic line type heat detectors consist of a capillary tube w/ hydrogen. As the temp rises, hydrogen is released and generates a signal.
9. Thermoelectric effect heat detector uses a thermocouple sensing element that produces increased voltage with increased heat generating a signal.
10. Thermistor type heat detectors provide increased resistance with increased temperature.

Proper application and use of heat detectors

Type of HD	**Best Application**
Fixed temperature	Spot type open air
Fusible link	Spot type open air
Bimetallic	Spot type open air
Rate of rise	Spot type open air
Line type	Cable trays, special appl
Sealed pneumatic	Cable trays, special appl
Rate compensation	Comp for thermal lag

11. Heat detectors are less prone to nuisance alarms
12. Heat detectors are suitable for hostile environments
13. Ceiling height has major impact on spacing for heats

Listing agency method to determine suitability

14. UL uses alcohol pan fire for heat detector testing
15. Spacing based on comparison with a 160º sprinkler

Special Reference: 4.7 Smoke Detectors

Related References Smoke Detectors pg 39

Principles of operation for all types of smoke detector

1. Ionization detectors use radioactive material to ionize air in a chamber making it conductive. Smoke particles decrease conductivity and detectors respond.
2. Photoelectric detectors use light scattering principle. Light is pulsed into a chamber, smoke scatters light onto a photosensitive cell. The detector responds
3. Photobeam detectors use light obscuration. A transmitter sends light to a receiver. Smoke blocks the light and a signal is generated.
4. Air sampling smoke systems are extremely sensitive. They draw air to a central processor, the air is analyzed and the presence of smoke generates alarm.

Proper applications for smoke detectors

5. Ceiling heights greater than 28' require an engineer evaluation to determine spacing
6. Smoke detectors require specific environmental conditions: temp 32-100 degrees, humidity 93% or less, air velocity 300 ft/min or less
7. Ionization detectors are best used when faster response is desired.
8. Photoelectric detectors are best for most applications
9. Photobeams work well for atriums & large open areas
10. Air sampling used in clean rooms, hyperbaric chambers, computer equipment rooms.

Fire response characteristics of each type of detector

Stage of Fire	Fire Signature	Detector
Incipient	Ionized particles	Ionization
Smoldering	Larger particles	Photoelect
Flame	Radiation energy	Flame det
Heat	High temperature	Heat det

Methods used by testing labs to determine listing

11. Test fires are much smaller for smoke detector testing than for heat detector testing
12. Smoke detectors are tested using 5 different fires burning 5 different materials. All smoke detectors must respond to all 5 fires. 2 produce black smoke, 2 produce gray smoke & 1 is smoldering w/ gray smoke
13. Detectors are adjusted to their least sensitive setting and are oriented in their least favorable position.
14. UL's tests are 5' light beam test, MIC test

Special Reference: 4.8 Radiant Energy Sensing Detectors
Related References Radiant Energy pg 40

Principles of operation for all radiant energy detectors

1.Infrared detectors. Employs an IR sensitive photovoltaic cell
2.IR spectrum wavelength range: 0.76-220 microns
3.IR viewing angle range: 15-170 degrees
4.Ultraviolet detectors. Uses solid state device or gas tube technology
5.UV operating wavelength range: 0.17-0.30 microns
6.UV viewing angle range: 90-180 degrees

Proper use of radiant energy detectors

7.Detector selection is based on matching the spectral response of the detector with the spectral emissions of the fire.
8.Sufficient detectors shall be used so that every point in the detection area is within the field of view of at least 1 radiant energy detector
9.Location and spacing for radiant energy detectors should be the result of an engineering evaluation which include the following:
   a. Size of the fire to be detected
   b. Fuel involved
   c. Sensitivity of the detector
   d. Field of view of the detector
   e. Distance from detector to the fire
   f. Radian energy absorption of the atmosphere
   g. Presence of extraneous sources of radiant emissions
   h. Purpose of the detection system
   i. Response time required
10.Design shall specify size of flaming fire & fuel
11.Spark detectors shall be placed so that all points on the chutes, conveyors or ducts are within field of view
12.Spark/ember detector spacing shall be based on the inverse square law for distance and fire size
13.Detector viewing windows shall be kept clean

Response characteristics for each type of detector

14.These characteristics are listed in 1-7 above

Methods used by testing laboratories to determine listing

15. No information available on this subject

Special Reference: 4.9 Computer / Microprocessor Based Systems
Related References None

Computer integration with fire alarm systems

1.All signal control & transport equipment shall be listed for use or (included routers, servers):
   a.Equipment shall meet the requirements of NFPA 72 including standby power requirements
   b.Programming and configuration allow for actuation time of 10 seconds or less
   c.System bandwidth is monitored to ensure operation of the system within 10 seconds. Failure shall be indicated within 200 seconds.
2.A listed barrier or gateway shall be attached to each control unit to prevent interference with other systems
3.Control units shall be reset or silenced locally
4.Remote reset & silence permitted with AHJ approval

Procedures for ensuring integrity of data

5.All circuits shall be monitored for integrity
6.Nonfire components may share fire components
7.Shorts, opens and grounds on nonfire system components shall not affect the fire alarm system
8.Provision for removal, repair, maintenance or failure of hardware, software or supplementary circuits shall not affect the fire alarm system

Suitability of various integrated circuits

9.Integration of environmental/maintenance equipment may include HVAC, temperature, presence of gases
10.Security system devices can be integrated into fire alarm systems.
11.Electronic door locks can be integrated into the fire alarm system. NFPA 72 requires the unlocking of all doors upon activation of the fire alarm system.
12.Integration of CCTV permits view of fire area
13.Integration of elevator control with recall / shutdown

Fundamentals of Boolean logic

14.Boolean logic forms the basis for simple computer programming. It reduces math to TRUE or FALSE equations.

Various types of memory used in fire alarm systems

15.PROM: programmable read only memory. EPROM: erasable PROM. EEPROM: electrically erasable PROM. RAM: randomly accessed memory